AMERICAN MACHINIST

JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 12, No. 36. WEEKLY. | NEW YORK, THURSDAY, SEPTEMBER 5, 1889. | $2.50 per Annum. SINGLE COPIES 5 CENTS

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The Cycloidal Tooth for Skew-bevel Gears.

BY GEORGE B. GRANT.

There is certainly no branch of the theory of the teeth of gears that can compare for intricacy and difficulty with that relating to the teeth of the skew-bevel or hyperboloidal gear. The various expert writers evolve complicated diagrams and interminable formulæ, and contradict each other in a manner that is bewildering to the novice in search of information, and leaves the impression that this item of knowledge may perhaps be too difficult for the human mind to thoroughly understand.

Olivier, who studied the matter as long ago as 1816, and was probably the first to scientifically attack the skew-bevel gear, contrived a peculiar "spiraloidal" tooth, and has left us a formidable treatise, bristling with the toughest possible mathematics.

Willis, some time afterward, 1840, proposed the cycloidal tooth, commonly and ignorantly adopted at the present day. He apparently relied on the strength of its resemblance to the same tooth for spur and bevel gears, for that keen observer and skilled mathematician would not have failed to have seen its true action if he had carefully studied it.

Rankine—and few rank higher in theoretical mechanics—adopted the cycloidal tooth without suspicion, so plausible is the fraud.

Herrmann appears to be the first to clearly show the inaccuracy of this tooth. He gives a universal law for the formation of all teeth, that clearly throws it out, but he does not seem to have as clearly seen its real action. He describes it as approximately accurate, as if it was serviceable, although not theoretically correct.

MacCord gives a demonstration to the same effect as Herrmann's law, showing that the supposed line of tangency is in reality a line of intersection. And yet he thinks enough of that form of tooth to elaborately describe it, and give methods for its practical application. This writer supposed himself to be the first to demonstrate the true action of this tooth, for in his preface he claimed that discovery. It was, no doubt, original with him, but, in points of novelty and scientific thoroughness, the universal law of Herrmann takes precedence.

Most practical writers who touch this subject, adopt the cycloidal tooth, and give rules for its construction; but there should be a thorough change in this respect, for that form of tooth will not work at all. It is wrong to even propose it as a makeshift or approximately correct tooth, for it will not work approximately unless the axes are very nearly parallel, or nearly intersect. This fact is shown by the work of the writers named, but not so definitely as to determine the actual amount of the error. They show the fact of inaccuracy, but do not measure it.

I have always found the skew-bevel gear to be a thing to be dreaded and approached with respect. No matter how much study is put into it, a satisfactory result is to be reached only by the skillful and persistent application of that good old rule, "Try, try again." The usually published method may serve as a starter to prepare the way for a second trial, but is not otherwise serviceable.

To determine whether the cycloidal tooth is really serviceable or not, I found it necessary to construct or draft the actual tooth, for the theoretical treatment and general reasoning is insufficient for that purpose.

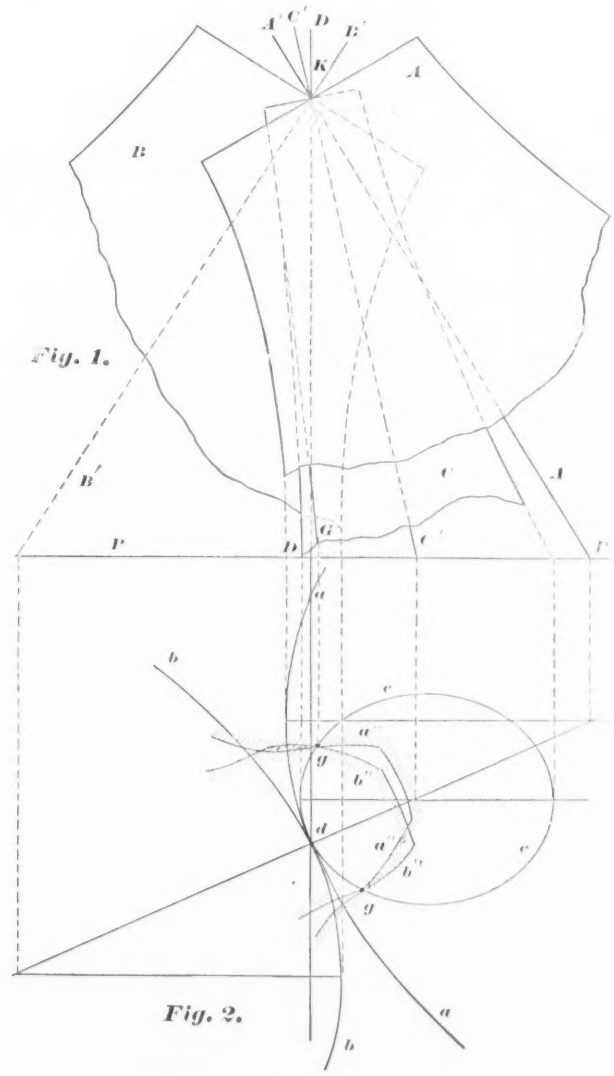


Fig. 1.

Fig. 2.

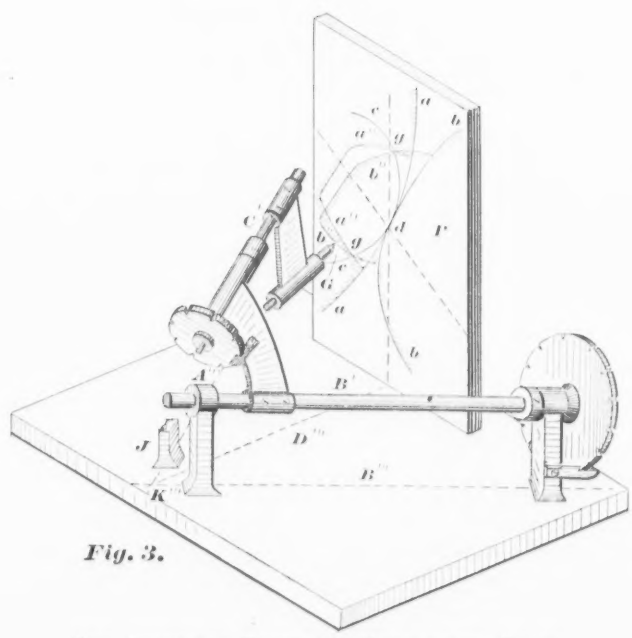


Fig. 3.

THE CYCLOIDAL TOOTH FOR SKEW-BEVEL GEARS.

As the construction of the actual surfaces would be exceedingly expensive, I adopted the method of drafting the curves alone by means of the mechanism to be described.

To clearly present the matter at hand, and the instrument for drafting the tooth curves, it will be necessary to describe the cycloidal tooth in a general way. Fig. 1 shows the pitch hyperboloids A and B, and the auxiliary hyperboloid C, rolling together on their fixed axes A', B' and C', and having the element or instantaneous axis D in common. An element G of the hyperboloid C, called the generatrix, will sweep up cycloidal surfaces on A and B. Fig. 2 shows a section of Fig. 1 by the vertical plane P; a, b and c are the sections of the hyperboloids A, B and C, while a'' and b'' are sections of the supposed tooth surfaces. As shown, these tooth sections always intersect on the section c as a line of action, and, as the solid parts of two teeth would interfere, they cannot act as gear teeth, or even be practically useful for that purpose, unless the interference is very little indeed.

Herrmann shows that these teeth are inoperative because their construction is not in accordance with a universal law, which requires the generatrix to so move as to be always parallel with the instantaneous axis. MacCord adopts the more direct but limited method of a demonstration that the surfaces intersect. Neither one of these methods was clear enough to show their inventors the true condition of the tooth. My method is to actually draft the intersecting curves of the section made by the plane P for some particular case, and it has the advantages that it is readily comprehensible without resort to complicated mathematical processes, and that it not only demonstrates the fact of interference, but measures its amount.

To do this, I constructed the simple instrument shown by Fig. 3, in which the parts are lettered to correspond with the other figures. The axis shaft B' carries an index by which it can be rotated and fixed in the required positions. The auxiliary shaft C' carries another setting index, and is firmly fastened to the shaft B'. The pointed generatrix rod G slides in a sleeve attached to the shaft C'. The vertical board P represents the section plane, and, as the two shafts are properly rotated, the rod G will prick points upon it in the required sections of the hyperboloids and tooth surfaces. The figure shows the instrument set to draft the faces b'''; and to draft the flanks a''', it is reset to the axis A, of which A''' K''' is the projection.

The action of the instrument is strictly correct, and the resulting drawing is far more satisfactory than actual surfaces would be—for the latter could not be made to fully interfere.

Fig. 4 (page 2) is a reduced copy of the work of this instrument. The dots show the points found by the instrument, and the lines are filled in to show the true shape of the whole tooth. It is seen that they interfere very badly, and that it would be useless to try to make them serve the required purpose with approximate accuracy. They are not gear teeth at all, and all the writers who have adopted them at all have been clearly wrong.

The figure shows a section at a considerable distance from the gorge line K, and a nearer section would show an increased interference. If the axes were nearly parallel, or nearly intersected, the interference would be less, but the axes are generally at right angles, and the case selected is fairly an average one.

Boiler Waters.

BY A. B. ROPES, SACRAMENTO, CAL.

The question of purity of water supply for boiler use is not of equal importance to all steam users. The saw mills, situated on the slopes of our great mountain ranges, need not use boilers constructed for strict economy

of fuel; and they can generally draw their water supply from brooks fed by the snows which whiten the mountain summits the year around.

On the other hand, the man who has a boiler to provide for on any of the great treeless plains of this country, knows to his cost that not only is fuel expensive and hard to get, but that the water found on "the plains" is at times almost unfit for boiler use.

Water, as it comes from the clouds, whether in the form of snow or rain, is free from all mineral matter. In its course down the mountain sides, or in percolating through various soils, it dissolves more or less of the soil through which it passes, and on subsequent evaporation in a boiler an accumulation of this substance is left in the boiler, some deposited as scale, while some remains dissolved.

Analyses of a great number of samples of water from different sources have developed the fact that the substances found dissolved in most river and well waters are few in number, and the influence of each on the efficiency of the boiler is well understood.

The dissolved elements most frequently found in waters, are:

Calcium, magnesium, iron, aluminum, sodium, potassium, sulphur, chlorine, carbon, silicon.

These elements are generally united so as to form the following "salts": Silicates, oxides of iron and aluminum, calcium carbonate (limestone), calcium sulphate (gypsum), magnesium carbonate, magnesium sulphate, sodium chloride (common salt), sodium sulphate, sodium carbonate.

The first six are likely to form *hard* scale, the scale being harder the greater the proportion of calcium and magnesium carbonates, and softer or more "sludgy" as more of the last three salts are present.

Results of analyses in this country are always given in "grains per gallon" of dissolved matter.

An excellent river water from the mountains flowing over sandy bottom, on analysis was shown to contain:

	Grains per Gal.
Total solids	4.320
Consisting of	
Calcium carbonate	2.053
Calcium sulphate	.920
Magnesium carbonate	.143
Magnesium sulphate	.220
Oxides	Trace
Silicates	.020
Sodium chloride	.964
Incrusting matter	3.356
Non-incrusting matter	.964

Incrusting matter in 1,000 gallons of water =.0.48 lbs. This is about as good water as one often sees in use in boilers.

The incrusting matter is found from the analysis by adding weights of lime and magnesium salts to the oxides and silicates. Sodium chloride being in this water is the only salt which we can, with certainty, class as non-incrusting. Analysis of boiler scale does not indicate the presence of any large amount of sodium or potassium salts in the hard covering that sticks so firmly to tubes and sheets.

Quite different from this water is one which came from the Great American Desert region of the southwest.

This water contained:

	Grains per Gal.
Total solids	84.056
Consisting of	
Sodium chloride	27.010
Calcium carbonate	20.956
Calcium sulphate	12.226
Magnesium carbonate	0.791
Magnesium sulphate	20.010
Oxides	0.116
Silicates	2.947
Incrusting matter	57.046
Non-incrusting matter	27.010

Incrusting matter per 1,000 gallons = 8 1 pounds.

Much trouble was caused by the use of this water. It caused boilers in which it was used to leak constantly around flues and stay-bolts, and it corroded sheets badly. This water, however, was not quite as bad as water from a "mineral spring," which was, on analysis, found to contain:

	Grains per Gal.
Total solids	225.311
Consisting of	
Sodium chloride	39.438
Sodium carbonate	23.714
Calcium carbonate	18.854
Magnesium carbonate	134.774
Magnesium sulphate	2.521
Oxides	1.108
Silicates	4.902
Incrusting matter	162.159
Non-incrusting matter	63.152

Incrusting matter per 1,000 gallons = 23.1 pounds. Of course no attempt was made to use this water in boilers.

This water, even when cold, was highly corrosive. An iron pipe, used to lead the water from the spring to a more convenient drinking place, was quickly corroded. A piece of the pipe, 3 feet long, contained a dozen holes, varying from $\frac{1}{8}$" to $\frac{3}{8}$" in diameter.

By comparing the analyses of different waters, and their action on and in boilers, it has been discovered that although, in saturated solutions, some alkaline salts have doubtless more or less corroding effect, the principal salts which cause corroding and pitting of boiler plates are the magnesium

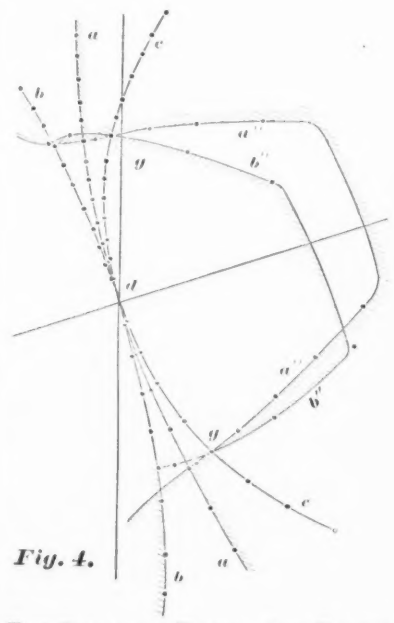


Fig. 4.

THE CYCLOIDAL TOOTH.—SEE PAGE 1.

salts. Indeed, so corrosive is the action of these salts, that 10 grains per gallon of salts of magnesium should be considered sufficient to condemn a water for boiler use.

The principal trouble caused by the presence of alkaline salts is foaming or priming if they are present in a greater quantity than 35 or 40 grains per gallon. The action of these salts in producing foaming is probably due to the comparatively high temperature to which the water impregnated with these salts has to be raised before steam is generated. On evaporating some alkali water for purposes of analysis, I once found that the thermometer, dipped in the evaporated and consequently strong solution of alkali salts, rose to 215°. The vapor, of course, *above* the water had a temperature of not over 212°, but the steam bubbles at the insant of disengagement from the bottom of the vessel must have had a temperature as high as the surrounding liquid. In a locomotive boiler, where the disengagement is rapid, it is easy to see how a diminution of pressure of the vapor above the water in the boiler, caused by opening the throttle or savety valve, would cause a rush of these bubbles of higher temperature, and consequently greater pressure steam toward the surface, and produce foaming.

The more nearly saturated the water in the boiler, the hotter it will have to be heated before the steam bubbles are disengaged, and the more violent will be the rush to the surface.

In railroad practice it is always best to keep below 50 grains of alkaline salts to the gallon in providing water for boiler use.

The waters found on the Dakota prairies are high in alkaline salts, and it is sometimes necessary to use water which begins to foam in a clean boiler before the engine has gone ten miles. I have seen thick brown sludge washed out of a boiler that had made a trip of 96 miles, which was so alkaline that it would clean grease from the hands like strong soap.

On analysis, a sample of the Dakota water was found to contain:

	Grains per Gal.
Total solids	184.00
Consisting of	
Sodium sulphate	129.25
Calcium carbonate	30.78
Magnesium carbonate	23.21
Oxides and silicates	0.76
Incrusting matter	54.75
Non-incrusting matter	129.25

Alkaline salts per 1,000 gallons 18.4 lbs.

This is a fair sample of such water as is to be had on Dakota prairies, by going from 30 to 75 or 80 feet below the surface, and sometimes surface water is nearly as bad.

Surface water taken from a slough on the prairies contained:

	Grains per Gal.
Total solids	66.67
Consisting of	
Sodium chloride	7.40
Calcium sulphate	35.95
Magnesium carbonate	13.32
Magnesium sulphate	9.00
Oxides, silicates, etc	1.00
Incrusting matter	59.27
Non-incrusting matter	7.40

Incrusting matter per 1,000 gallons, 8.4 pounds.

This water probably came from some stream. It evidently had not been deep enough to dissolve much alkali.

The foregoing comprise samples which approximate to the varieties of water ordinarily met with

With the results of these analyses before us, a word about boiler purgers may not be out of place.

The great majority of boiler purgers contain alkaline salts or caustic alkali, the object being to form a combination of the in soluble lime and magnesia scale with the alkali that will be soluble. With such waters as are represented by the second analysis such a compound might be of use; but with a Dakota alkali water it would be worse than useless, as it would be adding alkaline salts to a water already overcharged therewith.

Waters like the fourth mentioned are the hardest to deal with, and if their use can possibly be avoided by any expedient which will obtain surface water, it usually pay sto do it.

The use of a boiler purge does not by any means render the processes of blowing out and washing out less necessary. All of the lime and magnesium salts which were present as scale are not removed by the purge; they are simply softened, or in part dissolved; and it is just as necessary to remove them in this state as it was desirable to get them off of the sheets and flues; and besides the dissolved scale, there is all of the material of the purge to wash out in another form. There are some kinds of bark, also some vegetable products, which, when ground and introduced into boilers, soften a hard carbonate of lime scale. These mostly contain tannic acid, that, combining with the carbonate of lime, forms soluble tannate of lime. I have never had opportunity to observe the action of purgers on water high in alkaline, as well as lime and magnesia salts.

The bark of the eucalyptus seems to form a decoction which is a valuable scale remover.

Potato sprouts and barley sometimes clean scale from flues where the deposit consists mostly of carbonate of lime. To give an idea of the extra heat necessary to produce steam from water charged with alkaline salts, it may be interesting to note that in the process of analyses of alkaline waters similar to the sample from Dakota, there has been used three times the amount of heat to evaporate a second portion of liquid that was used for the first, *i.e.*, that with double the concentration three times the amount of heat was required.

In making fuel tests on locomotives there has been noted at various times an increase of from 0.4 to 0.6 of a pound of water evaporated per pound of fuel, brought about by washing out the boiler; and the boiler was not very dirty, either, nor was the water bad—containing 10 to 15 grains per gallon of total solids.

So important a problem has the question of water supply become to our largest railroad corporations, that some of them have had the chemists in their testing laboratories make an analysis of a sample of water from every water tank on the system. These analyses, together with information as to the sources of supply, other available sources, etc., etc., are put in a convenient form for reference. Where this has been done the company has been fully repaid for the expense incurred by analysis and arrangement, by an exact knowledge of the worth of each of the waters in use by them. The chemists of the different railroad laboratories some time ago formed an association known as the American Association of Railway Chemists. At one of the annual meetings of this association the question of boiler waters was discussed, and it was decided to grade "lime and magnesia waters"—*i. e.*, those containing mostly lime and magnesium salts, and a small proportion of alkalies—as follows:

Water containing less than 15.00 grains of *incrusting matter* per gallon shall be ranked "*Good.*"

From 15 to 20 grains, "*Fair.*"
From 20 to 30 grains, "*Poor.*"
From 30 to 40 grains, "*Bad.*"
Over 40 grains, "*Very Bad.*"

And this classification is now generally adopted by railroad chemists.

From these facts it is plain that any man who offers a scale remover "good for any water," either does not know what he is talking about or is running a risk of failure to keep his promises, or both.

It is only by an examination of the quantity and composition of the dissolved solids that any remedy can be prescribed with a good chance of success. Where fuel is at all expensive, a search for good water and examination of that from available sources will often pay for the trouble incurred in a few weeks, by increased efficiency of the boiler.

A device which would save 10 per cent. of fuel would be worth looking into for a large plant. Why would not a *water* that would save 10 per cent. of fuel be just as valuable?

And there are many plants drawing water from deep driven wells which could get better water at a less depth. As a general thing, two or three wells furnishing surface water are better than one deep well that gives not only water, but the "salt of the earth."

At the private sale of the tools and machinery of the Hinkley Locomotive Works, recently, a gentleman offered $300 for a tool, and his offer was accepted. Afterwards he concluded he did not want it, and the bargain was annulled. At the auction sale the same gentleman was present and bid off the rejected tool for $310, never knowing it was the one he had declined at $300 until he was rallied about it. It is said if the cigar bills were added, the cost would be very materially more than he bid for the tool.

In view of recent railroad accidents, Samuel Avery, M. D., writes us to repeat a suggestion he made some years ago as to the construction of cars. The suggestion, which was first made from experience on a train that run off a misplaced switch, the result being some loss of life, although the speed was slow at the time of this accident, was to make iron cars, making the ends pointed in such a manner that they could not telescope.

The next meeting of the Institute of Mining Engineers will be held at Ottawa, Ont., beginning on Tuesday evening, October 1. Several excursions are planned for the time of the meeting, and at the close there are other excursions planned for those who will remain.

The Great Bell and the Big Gun of Moscow.

A year or two ago a Russian engineer, Mr. Paul Bocharoff, traveled through the United States, working for short times in steel and iron works, in order to get knowledge of American practice. During that time he worked about four months in the Thomas D. West Co.'s foundry, at Cleveland, Ohio, and a strong friendship sprang up between him and Mr. West. Recently he returned to Russia, and, agreeable to promise, he sent Mr. West an account of the casting of the "Great Bell" and the "Big Gun." Mr. West kindly permits us to take the following from Mr. Bocharoff's letter in regard to these subjects. Mr. Bocharoff writes:

Moulding of the big bell was commenced in 1732, by a Russian foundry foreman, of the Royal Gun Factory. His name was John Motorin; he had for help four carvers and pattern makers—Cobeleff, Galkin, Cogteff and Serebriakoff, and one moulder's foreman, Peter Loukovnikoff. Wages had been 6 rubles per month, that is, $4.60, and the last one received only 5 roubles per month.

In January, 1733, nearly 100 different workmen were engaged in preparations, and work was kept going till Nov. 26th, 1734; at this time everything was ready for casting, and the mould was dry.

There were four air furnaces (reverberatory); in these was placed 5,723 poods and 4 pounds of bronze from an old bell that was broken down before. Fire was started at 4 o'clock P. M., and in the night the metal had commenced to melt down. Then was added, on Nov. 27th, 5,276 poods, and 36 pounds of bronze more. On Nov. 28 was added 2,000 poods more of tin and copper, and everything was all right until 11 P. M. of Nov. 28.

Then two furnaces gave way, and all the metal went down into the ground. They lost 6,500 poods; and it was 1 A. M. when they added some old bells to the remaining two furnaces, then took from the arsenal and threw into the furnaces 600 small bells—1,663 poods altogether. Then they brought from the gun factory 4,137 poods of small bronze coin and 300 poods of tin, and sent down town and bought some 400 poods more of tin.

At 7 A. M. of Nov. 29th the two other furnaces had given way, and all the bronze went through the bottom into the ground. The heat was so great that the crane took fire, and everything was burned down, but the mould was not destroyed, becoming only a little wet.

In 1735 John Motorin died, having transmitted his work to his son, Mykel Motorin, who had been his helper all the time.

Nov. 23d, 1735, the furnaces were ready again, the fire was started, and Nov. 25th the bell was cast all right. On the bell was the inscription to the effect that it was cast in 1733, but that is not right. The mould was made in that year.

All preparations and work, except the price of metal, cost 62,000 rubles—nearly $47,770.

The height of the bell is 19 feet 3 inches; circumference, 60 feet 9 inches; thickness of walls in the thickest part, 24 inches; in the thinnest part, 8 inches. The weight of the bell is 12,327 poods, 19 pounds = 443,790 English pounds. One pood = 36 English or 40 Russian pounds.

The bell was cleaned of the sand in the spring of 1737; then it was left in the pit on an iron grate, laid on twelve oak piles. That grate served probably as the bottom plate in making the mould. The sides of the casting pit were covered with wood logs.

On May 29th, 1737, there was a big fire in Moscow, and the cranes and the building that was over the bell were burned down, and all burning beams fell down into the pit; this heated the bell, and gave it eight cracks, one piece about 7 feet square and ten tons weight being broken out.

The bronze of the bell contains 84.51 per cent. of copper, 13.25 per cent. of tin, nearly 1.25 per cent. of sulphurus, and the remainder some traces of silver, zinc and arsenic.

The bell was in the ground till March, 1836; then the pit was cleaned out. It was 30 feet deep. April 30, 1836, it was started to lift the bell out, but there was not sufficient ropes to lift it safely, and the lifting was delayed till July 23. In 42 minutes and 33 seconds the bell was lifted out of the pit. Beams had been placed across the pit; the bell was lowered on them, and then moved a distance of 140 feet and placed on a granite foundation.

All work had been finished Aug. 4, 1836; then there was made a bronze ball with a cross, and placed on the bell.

The bell is in style Renaissance; there are figures of King Alexis Michailovich and Empress Anna Toannovna; but only the faces and the upper part of the body are cleaned out; the lower parts are covered with burned sand. The bell is not cleaned yet; most part of the ornaments and letters are filled with scales of burned sand.

There is a wrought-iron tongue under the bell; it is 17 feet long and 2 feet thick on the end, but it does not belong to this bell; probably it is from a former one.

The big gun was cast in Moscow by a Russian foundry foreman, Theodor Chochoff, in the year 1594, in the reign of King Theodor, son of King John. The gun is of bronze; it is 17 feet 6 inches long, 4 feet outside diameter, and 3 feet inside diameter; I measured it myself. Inside, at the bottom, is a powder chamber, about 1 foot diameter, 5 or 6 feet long. The gun is 2,400 poods weight; that is 86,400 pounds.

The Sand Core Process.

This is a peculiar and original process, and may be thus briefly described: When it is desired to apply it to steel manufacture, a case or box of sheet-iron is made of the size desired. This is filled with finely-powdered silica or fine sand, and placed in the mould a few inches from the bottom, so that the melted metal will run under and around its sides to the desired thickness. The metal is poured in and the work continued until the box containing the silica is covered on the top as well as on the bottom and sides, so that, when the process is completed, it contains within it the box of silica. The ingot is now ready to be manipulated as if it were solid steel, and can be rolled or drawn to a rod of less than one inch in diameter, or hammered into flat plates, or any other form desired. No matter how finely drawn or flattened, the sand core will be found in the center with the steel cover evenly distributed over it. The sand core, it is found, has the property of expanding and contracting equally with the metal covering it, so that, when the article made from it is completed, it is found to be so compact and solid as to give additional strength and rigidity to the article in which it is situated; this property makes it especially valuable when used for pillar supports or beams in building; for, in cases of fire, the core, being a non-conductor of heat, would prevent the column or beam from getting hot enough to impair its usefulness and safety. By this process, by varying the method of making the core, so that it can be withdrawn, tubing of superior quality and strength can be made; even common gun barrels, etc.—*Iron and Steel Trades Journal.*

INDICATOR DIAGRAMS FROM THE ENGINE OF THE STEAMSHIP CITY OF BERLIN.

Indicator Diagrams from the Engine of the Steamship City of Berlin.

In our issue of July 11, reference was made to the steamship City of Berlin, and to the performance of her engine. We present with this, indicator diagrams from the three cylinders of this engine. The engravings are made from the original diagrams, and full size, so they can be used with confidence by those who wish to make calculations from them. The cylinders are 41", 65" and 101" diameter; stroke of pistons, 5 feet 6". This, at 66 revolutions, gives a piston speed of 726 feet.

A criticism likely to be passed upon these diagrams is lack of getting very near boiler pressure in the high-pressure cylinder; it would appear that a falling off of 20 pounds was too much. Having at hand steam of 149 pounds pressure, it does not look to land engineers like the best engineering to get an initial pressure of only 126 or 128 pounds. As the cut-off is at about two-thirds stroke, this lack in initial pressure is not probably due to the use of the link motion; in fact, the links are working at nearly their full stroke.

The vacuum in the low-pressure cylinder is hardly as good as might be expected—the vacuum gauge was 26"—but generally the features of the diagrams will be considered such as show good steam distribution for marine engines at that piston speed. It will be noticed that less work is done in the intermediate cylinder than in either of the others. This is purposely so; equalizing the work calls for the consumption of more coal.

The horse-power developed in the three cylinders is 5,762. To do this work requires the consumption of 9,150 pounds of Welsh coal per hour. But some of this coal is burned in the donkey boilers, and steam is used from the main boilers for other purposes than supplying the main engine. With no exact means of coming at the matter accurately, it appears that the main engines require 1½ pounds of coal per horse-power per hour.

Effect of Reducing the Weight of Marine Boilers.

From a leader in the *Engineer* (London) it appears that the engines and boilers built in recent years for the English ships of war are defective, so much so, that, before the magnificent Spithead fleets began their mimic warfare, several vessels had broken down. The cause of the defects is the determined effort to reduce the weight, limit the dimensions and augment the power of the machinery on which the ships depend for their propulsion. The persistent breaking down of marine engines and boilers has alarmed the authorities, and a fiat has gone forth that weights and dimensions must be increased. Particular attention is drawn to the boilers, many of which have leaky tubes, caused by making the latter too thin, so as to keep down the weights of the boilers. Tubes of this kind will leak, the expander is used repeatedly, and the tubes are at last almost cut through. When a heavy strain comes on them the ends are pulled off, and a rush of water under a pressure of 150 pounds or so takes place. Consequently the boilers always break down the same way, and sometimes with serious results; one instance is mentioned in which five firemen were badly hurt, burnt and scalded. Forced draught is said to have a great influence in the breaking down of boilers. The tubes are crowded too close to the flanges of the tube plates, and the latter are made too thick, giving too much rigidity. When forced draught is used the tubes become much heated; they expand, and because the tube plates cannot go with them they are forced through the plates. The moment the temperature falls from any cause they contract, slip in the plate and leak. Greater flexibility in the tube plate is insisted upon, which, it is thought, will prevent the leaking of tubes, whether forced draught or no forced draught is used. Yet attention is drawn to the difficulties which may arise in using forced draught—fire bars may be melted and furnace crowns ruined. Any attempt to get more steam out of a marine boiler than it can legitimately supply is said to be simply to court disaster.

A good deal of wonder is expressed at the fact that immigration to this country shows an enormous falling off; also, that a good many immigrants are returning to Europe. This last is said to be particularly true of skilled workmen. After all, there appears to be nothing remarkable in the fact that fewer skilled workmen come here. In most instances, when they come they get work, if at all, by crowding some one else out of a place. At the present, in most trades, there are quite as many men in this country as can find work at fair wages, and, generally speaking, business is very good indeed in Europe. Skilled workmen are, as a rule, the most intelligent, and are not long in finding out that they cannot pick up gold on the streets in this country, nor always find a job when they get here. There is plenty of material here out of which to make mechanics in sufficient numbers to supply the demand, and there is no lack of laborers. We have little doubt that it would be quite as well for the country, if the falling off were still more pronounced.

Modern Locomotive Construction.

BY J. G. A. MEYER.

NINETY-NINTH PAPER.

In the following rules relating to safety valve problems, the weight of the valve, lever and spindle is to be taken into account. These weights must be accurately ascertained, either by actual weighing or by computation.

For convenience and ready reference we have reproduced Fig. 553.

The weight of the safety valve lever will act on the valve with a leverage which is equal to the distance from the center of gravity of the lever to the fulcrum. In other words, we assume that the whole weight of the safety valve lever is concentrated at its center of gravity G (Fig. 553), and acts with a leverage C.

When the safety valve lever is of uniform thickness and uniform width throughout, and the shape of one end exactly like that of the opposite end, we may, for all practical purposes, assume the center of gravity to lie in the center of the lever, and, indeed, it will be there exactly, provided no holes are drilled through the lever, and the metal is homogeneous.

When the lever is not of uniform thickness throughout, then, in order to find the center of gravity, the lever should be balanced on a knife edge, and when in equilibrium, the center of gravity will lie in a vertical line on the lever drawn from the knife edge.

When the lever is of uniform thickness throughout, but not of uniform width, we may also find the center of gravity by balancing the lever on a knife edge. This method may not always be convenient; in such cases we may adopt the following method, which will give us an approximate position of the center of gravity; but it should be distinctly understood that this method is only applicable to levers which have a uniform thickness. Nearly all safety valve levers for locomotives are of uniform thickness, with the exception of the small hub around the center line $e e_2$, in Fig. 553. To allow for this hub, assume the lower edge of the lever to extend clear to the end of the lever, and proceed as follows: Cut a template out of stiff paper, conforming to the width of the lever. Anywhere near one of the edges of this template punch a small hole, for instance at A (Fig. 553a), and suspend the template from a pin passed through this hole, allowing the template to have plenty of freedom to vibrate; also, from the same pin suspend a plummet line, and along it draw a pencil line $A\ B$ on the template. In a similar way suspend the template from another hole C, punched anywhere near the edge opposite the hole A; along the plummet line draw on the template another pencil line $C\ D$, cutting $A\ B$ in the point G, which will be the position of the center of gravity.

The preliminary details having been arranged, we are in a position to establish a formula, from which all subsequent rules relating to the safety valve can be deduced.

Since these rules will be interesting examples of the principle of moments, it may be advantageous to repeat the definition of the moment of a force given in our fifty-ninth paper.

The moment of a force with respect to a point is the product obtained by multiplying the force by the perpendicular distance from the point to the direction of the force.

Now the point referred to in this definition is the center of the fulcrum pin in Fig. 553. About this point there are four forces acting, namely the steam pressure acting in the direction of the vertical line through the center of the valve; the total steam pressure is evidently equal to $P \times A$ (here the same symbols are used as given in the last paper), hence, according to our definition, the moment of this pressure about the fulcrum is equal to $P \times A \times B$. Second, the tension acting in the direction of the vertical line $e e_2$, hence its moment about the fulcrum is equal to $T \times L$. Third, the weight W_2 of the valve and spindle acting in a direction of the vertical line through the center of the valve, hence its moment about the fulcrum will be $W_2 \times B$. And lastly, the weight W_3 of the lever, acting in a vertical line through the center of gravity G, hence its moment about the fulcrum is equal to $W_3 \times C$.

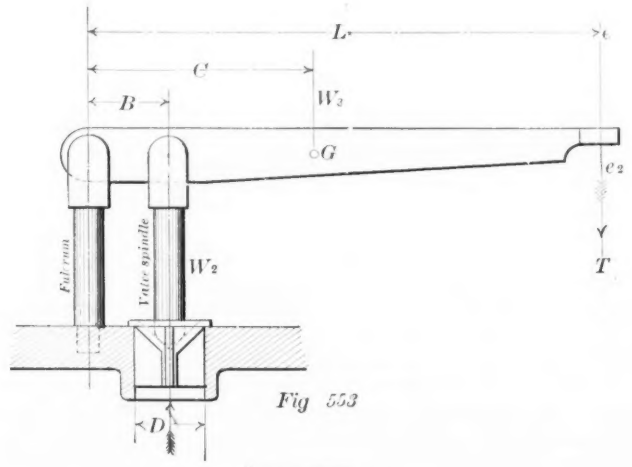


Fig. 553

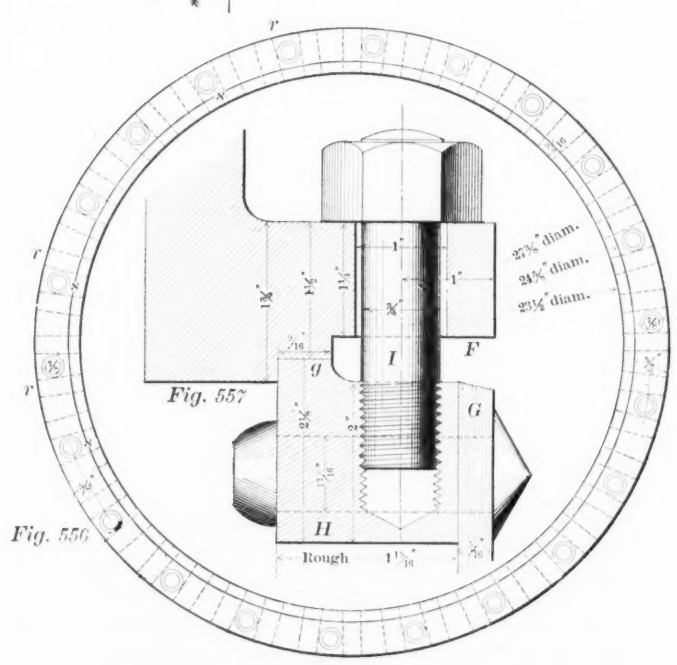


Fig. 556 Fig. 557

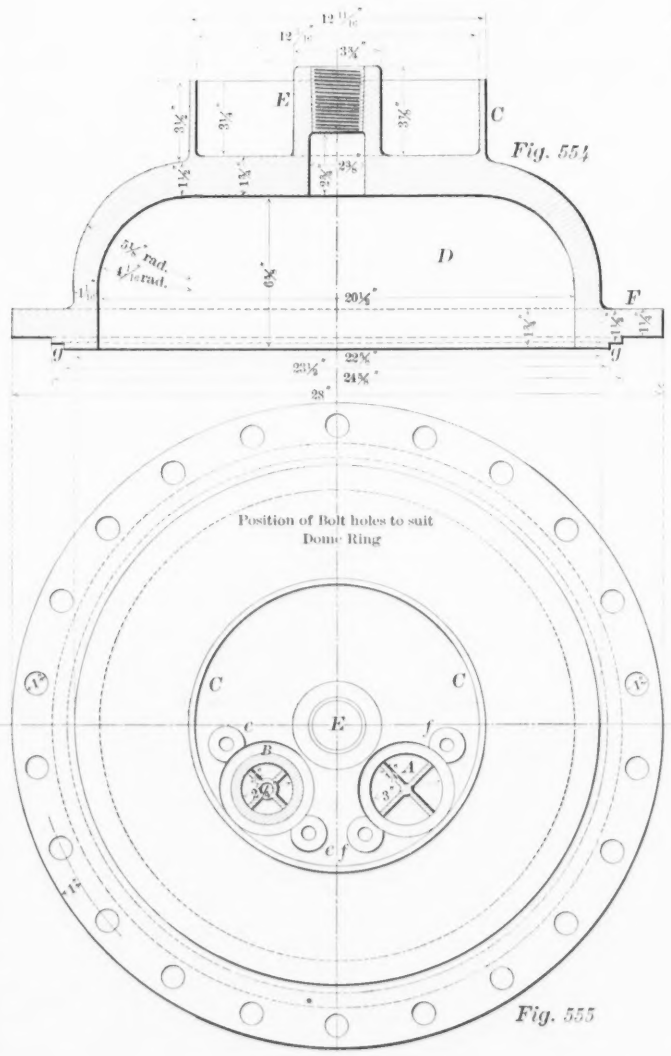


Fig. 554 Fig. 555

Fig. 553a

Moment of the tension T about the fulcrum $= T \times L$.

Moment of the weight W_2 about the fulcrum $= W_2 \times B$.

Moment of the weight W_3 about the fulcrum $= W_3 \times C$.

Sum of the downward moments $= (T \times L) + (W_2 \times B) + (W_3 \times C)$.

Since the sum of these moments must be equal to the upward moment, we have:

$$P \times A \times B = (T \times L) + (W_2 \times B) + (W_3 \times C). \qquad (b).$$

From this formula all rules relating to the safety valve can be deduced.

Example 6.

Tension of the springs $T = 72.27$ pounds.

Length L of lever $= 38.5$ inches.

Weight W_3 of lever $= 11$ pounds.

Distance C of center of gravity of lever from the fulcrum $= 15$ inches.

Weight W_2 of valve and spindle $= 5$ pounds.

Distance B from center of valve to fulcrum $= 3.5$ inches.

Area A of the valve $= 7.06$ square inches.

Find the steam pressure P per square inch.

Here we are to find P, hence from formula (b) we obtain

$$P = \frac{(T \times L) + (W_2 \times B) + (W_3 \times C)}{A \times B} \qquad (6).$$

Which reads:

Rule 6. Add the moment of the tension, the moment of weight of the valve and spindle, and the moment of weight of the lever; divide this sum by the product obtained by multiplying the area of the valve by the distance from the fulcrum to the center of the valve; the quotient will be the steam pressure per square inch on the valve.

In this and the following rules, all the dimensions should be taken in inches, and the weights in pounds.

Substituting the numerical values for the symbols in formula (6), we have:

$$P = \frac{(72.27 \times 38.5) + (5 \times 3.5) + (11 \times 15)}{7.06 \times 3.5}$$

$$= 119.9 + \text{pounds.}$$

Example 7. The steam pressure per square inch is 120 pounds; the weights and dimensions of the safety valve are as given in example 6, with the exception of the area of the valve, which is to be found.

Here we have

$$A = \frac{(T \times L) + (W_2 \times B) + (W_3 \times C)}{P \times B} \qquad (7).$$

Which reads:

Rule 7. Add the moment of the tension, the moment of weight of valve and spindle, and the moment of the lever; divide this sum by the product obtained by multiplying the steam pressure per square inch by the distance from the fulcrum to the center of the valve; the quotient will be the area of the valve in square inches.

Substituting the numerical values for the symbols in formula (7), we obtain

$$A = \frac{(72.27 \times 38.5) + (5 \times 3.5) + (11 \times 15)}{120 \times 3.5}$$

$$= 7.05 \text{ square inches.}$$

Example 8. The steam pressure is 120 pounds, the weights and dimensions of the safety valve are as given in example 6, with the exception of the distance from the fulcrum to the valve, which is to be found.

Here we are to find B, hence

$$B = \frac{(T \times L) + (W_2 \times B) + (W_3 \times C)}{A \times P} \qquad (8).$$

Which reads:

Rule 8. Add the moment of the tension, the moment of the weight of the valve and spindle, and the moment of the weight of the lever; divide this sum by the product obtained by multiplying the area of the valve by the steam pressure; the quotient will be the distance from the fulcrum to the center of the valve in inches.

Substituting the numerical values for the symbols in formula (8), we obtain

$$B = \frac{(72.27 \times 38.5) + (5 \times 3.5) + (11 \times 15)}{7.06 \times 120}$$

$$= 3.49 \text{ inches.}$$

In order to find the tension we must change our original formula (b) to the following:

$$(P \times A \times P) - (W_2 \times B) - (W_3 \times C) = T \times L. \qquad (c).$$

From this we obtain

$$T = \frac{(P \times A \times P) - (W_2 \times B) - (W_3 \times C}{L} \qquad (9).$$

Which reads:

Rule 9. From the moment of the steam pressure subtract the moment of the weight of valve and spindle, also subtract the moment of the lever; divide the remainder by

the length of the lever; the quotient will be the tension in pounds.

Example 9. The steam pressure is 120 pounds per square inch ; all other dimensions are as given in example 6, excepting the tension, which is to be found.

Substituting the numerical values for the symbols in formula (9), we have

$$T = \frac{(120 \times 7.06 \times 3.5) - (5 \times 3.5) - (11 \times 15)}{38.5}$$

$= 72.27$ pounds.

For finding the length L of the safety valve lever when all other dimensions and weights are given, we have the following formula:

$$L = \frac{(P \times A \times P) - (W_2 \times B) - (W_3 \times C)}{T} \quad (10).$$

In this formula we have taken into account W_3, which is the weight of the lever, and C, which is the distance from the fulcrum to the center of gravity of the lever, and, since these cannot be accurately determined unless the length L of the lever is known, we are compelled to assume a value for $W_3 \times C$.

Probably under these circumstances it will be best to find the length L of the lever by formula (2), last paper ; the length L thus found will be somewhat longer than that obtained by formula (10).

The safety valves are generally attached to a cast-iron dome top, the proportions of which are shown in Figs. 554, 555 ; the relative positions of the safety valves and whistle are also given.

The safety valve, such as is shown in Fig. 553, is placed in the opening A, and the locked safety valve, or pop valve, is placed in the opening B. The whistle is screwed into the central hub E, and stands forward of the safety valves.

When the ordinary plain safety valve is used, we do not require the hubs f, f, shown in Fig. 555; yet these are generally cast to the dome top so that any other safety valve can readily be attached. The basin C is simply for the purpose of collecting the water due to the condensation of steam as it flows through the safety valves and whistle.

Fig. 556 represents a plan of the dome ring, and the arrangements of the rivet holes r, r, and the stud holes s, s.

Fig. 557 represents, on a larger scale, the joint between the dome top and the ring ; this joint is a ground one. F represents a section of the dome top flange, and H a section of the ring. Here it will be seen that the holes s for the studs I are not drilled through the ring; this precaution is taken to prevent leakage around the studs.

Sometimes the rings are placed outside of the dome; in such cases bolts are used for fastening the dome top to the ring.

Shop Notes.

By JARNO.

No. 17.

A SCREW BROKE—SCREWS PENED.

One of Labrihed's workmen, in trying to straighten a screw seven-eighths inch in diameter and about four feet long, broke it with a rawhide hammer. The stock was good; the blows were not heavy, yet, the break was clean. What was the reason of the screw's breaking? Perhaps the diameter, the length and the weight were in such proportion to each other as to favor the greatest vibration. The loss gave Labrihed some concern as to whether it is just the thing to strike any screw with a hammer. He wished to know what I thought. I asked whether he had ever tried pening. He replied, "I have never heard of this method; if it is generally known, I must plead inexperience, and will call myself a novice if you will explain. To me, the subject of straightening screws is, just now, of considerable interest."

I have seen pening applied to screws having flat bottom threads, though probably V thread screws can be straightened by pening. The operation consists in striking the bottom of the spaces between the threads on the hollowing side of the screw, with a blunt chisel, while the rounding side is supported by a piece of wood. In the figure, A is the blunt chisel. The work is conveniently done on the centers of a lathe. A screw yields readily to pening—so readily as to surprise one that sees the operation for the first time. The first care should be not to pene more than is necessary in any one place, in order to avoid short crooks.

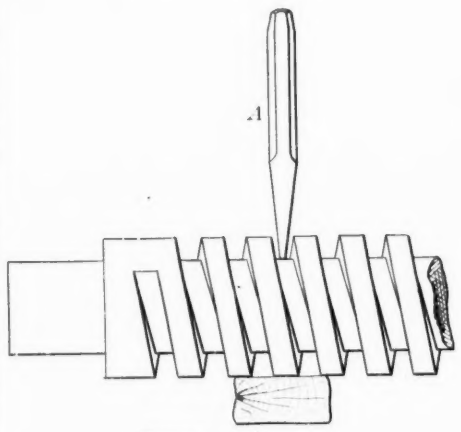
The Suction of a Chimney.

By W. H. BOOTH.

It is so common to hear the suction of a chimney spoken of and discussed as a factor in the production of the draught of a furnace, that one is sometimes really led to take it to be an existent fact.

Actually, there is no such thing. A chimney exerts no suction whatever; it cannot possibly do so, for it has an open top, which admits the full pressure of the superincumbent atmosphere. As, however, the suction is supposed to exist, and believed to be a power, it is very clear that the nature of draught is not understood, and never will be, until a proper and correct idea of its true action is obtained.

Looking at nature, we know that when the lower stratum of the atmosphere is heated by radiation from a comparatively small area of dry and arid country, the cooler air from surrounding districts rushes in, and wind results. Here there is no suction. A portion of the lower atmosphere is made to expand by heat, and other cooler air gets below it by virtue simply of superior gravity. In a furnace and chimney, our object is to produce a small edition of nature. We do this by heating a column of gas, about 100 to 300 feet in height. So heated, the gas, which is ordinarily composed of about one pound of carbon burned with about 24 pounds of air, is practically but little heavier than pure air at the same temperature, especially if the fuel contains hydrogen. Heated to about 575 degrees, the column will be of double its volume at an ordinary temperature of 60°, and will, with the atmosphere above it, exert a pressure on the ground less than that of the surrounding atmosphere by the amount of half the weight of the column.



PENING A SCREW.

A cubic foot of air weighs about .08 of a pound. For heights of 200 feet above the ground, the density of the atmosphere is practically constant. On this assumption, the pressure of a column of air 200 feet in height will be 1,600 pounds per square foot, or .11 pounds per inch, practically, 1.77 ounces. By heating this column, we reduce its pressure to .88 of an ounce per square inch, or by one-half.

Now, a pressure of one ounce is equal to a column of water nearly 1¾ inches (1.733 in.) Therefore, .88 of 1.733, or 1½ inches of water, is the amount by which we have reduced our local atmospheric pressure by means of a fire.

Owing to various circumstances, it is difficult to obtain a steady inrush of surrounding air to our fire, and on this account, therefore, we surround our heated column of air by a casing, which shuts it off from surrounding atmosphere, keeps it over one small spot of ground, and keeps it warm.

This casing we call a chimney, and we make one entrance to this chimney for the purpose of allowing the greater external pressure to obtain an entrance. Across this one entrance we place a grid, and on this grid a fire which heats up all air entering the chimney, and preserves a constant current. Such is a simple statement of the method for producing a draught. From it we perceive that a chimney is only for protective and controlling purposes, and it enables us to determine the height of heated column to a nicety. Draught is simply the effect of opposing a column of air at a pressure of about (say) 34 feet of water by another column of about 33 feet 10½ inches only in the case in question. Wherever an opening is made into a chimney, the external air will rush in at such opening, simply because within the chimney the pressure is less.

Wherever the brickwork of the flues is bad, air will rush in, and sometimes, where the flues are very long and in poor order, the supply of air thus getting in is so great that the amount which enters at the furnace is much reduced in consequence, and there is said to be a poor draught. Flues require to be tight, just as do the parts of a steam engine in which there is a "vacuum." The "vacuum" is spoiled by leaking in of air, and there is a less tendency for the entry, by the intended door, of steam from the boiler, which in its endeavor to enter the vacuous space, is made to move a piston against a big resistance, and so we get work performed.

Now that we recognize clearly that the outer air causes draught, and not any power of a mere casing called a chimney, we begin to see why on a frosty day we get a better draught. We see other matters more clearly also.

It is usual to place dampers between the furnace and the chimney as a means of regulating draught. There are frequent cases where such a position is wrong. For example, in burning bituminous or hydrogenous coals, it is absolutely requisite to complete smokeless combustion, to admit large quantities of air above the fuel for a short time after each fresh charge of fuel. When a boiler is being lightly worked, the demand for steam being small, the attendant will close the chimney damper, and thus check the draught and admit very little air through the fire. It is, however, necessary to fire up occasionally, and when this is done, smoke rolls in volumes from the fresh green fuel. But the damper is so nearly closed, that, though the openings for admission of extra air to burn the gases are opened up, no extra air, or but little, can get in, because its inflow is resisted by stoppage of the way to the chimney. Dense smoke is the result of this faulty working.

Suppose instead, however, that the chimney damper be left open, and a new damper be fixed to the ash-pit opening, by which air can be kept from entering under and through the fire grate. Then, when the call for steam is small, this damper is closed, and combustion goes on as slowly as if the chimney damper itself were shut down. When fresh fuel is thrown on, and the openings for air above the fire are operated, the air will pour in at these, and consume the gases evolved, for the way to the chimney will be clear, and air can enter the openings, and does so freely. When the gases are burned off, of course the openings for air are closed, and slow combustion of the solid fuel goes on as before, the draught to the grate being checked by the ash-pit damper. It is only because in so many cases, as in cotton factories, the full power of the boilers is called for all the time, that the unscientific nature of the chimney damper has not made itself more felt. Of course, a chimney damper is a necessity, to be used in times of cleaning, etc., but in the ordinary working of a boiler, the power of closing up the ash-pit is of far more scientific and practical use. By it, the gaseous portions of the fuel may be made to do duty in steam raising, and smoke will not be turned out. Ash-pit dampers, too, are, as a rule, handier to couple up with an automatic regulating apparatus, and generally far easier to use than chimney dampers.

Taking the density of the gaseous products of a furnace as equal in the mean to that of the air, the following table will be useful to determine the densities to be used in calculations at various atmospheric and flue temperatures:

T.	D.	T.	D.	T.	D.
32°	1.000	110°	.863	500°	.512
40°	.984	120°	.848	550°	.487
50°	.964	200°	.745	600°	.464
60°	.946	250°	.693	650°	.443
70°	.928	300°	.647	700°	.424
80°	.911	350°	.607	800°	.311
90°	.894	400°	.572	900°	.361
100°	.878	450°	.540	1000°	.337

The figures are calculated from the well-known coefficient of expansion per degree of heat of $\frac{1}{491.4}$ of the bulk at 32° Fahrenheit.

As a cubic foot of air at ordinary temperature weighs about .08 of a pound, the force acting to produce a draught is clearly the difference between a column of air at this density and a heated and lighter column. Hence, the pressure per square inch in ounces being obviously $\frac{16}{144}$ of .08, or say, .009 ounces, the force available for any chimney of a height H in feet will be $p = .009 \times H(D - d)$ when D and d are the densities, cold and hot found from the above table, allowing 1.733 inches of water per ounce; this gives at once 1½ inches for each 100 feet of chimney height for a column of air cold, which, multiplied by $(D - d)$ gives the draught per 100 feet of height.

When a U-tube gauge is applied to the base of a chimney, it should show the full difference of pressure between the chimney column and the external air, because the water in the U-gauge is pressed from without by atmospheric pressure.

At the furnace door, the gauge difference is much less, and this is held as a proof of the suction of the chimney, which is thought to be destroyed or vitiated in having to pull through so great a length of flue between the chimney base and the furnace. Actually, however, this loss of gauge difference is due to friction between the furnace and the chimney. The outer column of air, pressing in at the furnace door, rests, by means of its adhesion to the rough brick of the flues and its own resistance to bending round a corner, upon the whole inner surface of the flues, and is able to oppose a resistance to motion against the entering cool column. When flues are long and cramped, this frictional resistance between chimney and furnace is so great as to almost absorb the difference between the two columns, and the nominal entering force is so much checked that we say the draught is very poor. As air enters the furnace at about 60°, and goes over the bridge wall at perhaps 1,000° or 1,500°, its bulk is augmented to double or treble. This means an enormous expansion of volume in the furnace. This expansion to threefold volume takes place in every direction, and must act, therefore, against the incoming air, and thus we get another reduction of the U-gauge difference.

Sometimes the space above the bridge wall is altogether too contracted to pass the volume of heated gases from the furnace, and many poor draughts arise solely from this cause. The remedy is obvious, to knock off—often done with the rake—the top row of bricks from the bridge. More poor draughts are caused by cramped tortuous flues than anything else, and a good chimney is frequently nullified by this cause. No flue should be so small as not to permit the easy passage of an inspector or cleaner in such a posture that he can work efficiently. The old fallacy that brick flues should come close to the boiler shell is now quite exploded ; for, in flues of small area, the power of the draught is being used up in friction of rapidly flowing gases, and heat is produced by such friction, whereas it should be in process of absorption. When flues are damp they are often found associated with a poor draught. This is probably to be explained partly by the cooling effect of evaporation of the moisture, and partly by the filling of the flues with steam formed from the moisture, so occupying the space which should be occupied by the gases from the furnace.

Understanding now the cause of draught, we may go on to consider how it is that the

gauge of water, as shown at the chimney base, is so much depreciated in the furnace, and in what way, by the assistance of a steam jet, or of a fan, or an exhauster, draught may be improved and combustion accelerated. Such considerations may very well form the subject of a second paper.

Self-Setting Plane.

The cut herewith presented illustrates a sectional view of the self-setting bench plane made by the Gage Tool Co., of Vineland, N. J. We have previously illustrated this plane, but the arrangement for showing the method of adjusting the iron throat was deficient. The cut shows a screw passing from the back of the iron throat through and into the steel bar which extends through the plane block. There are two of these screws, one on either side of the back of the iron throat, which gives a perfectly solid attachment to the plane stock.

LETTERS FROM PRACTICAL MEN.

The Ignition in the Gas Engine.

Editor American Machinist:

From articles in the London *Engineering* of late dates, I judge that the best system of ignition of the charge is hardly yet determined. I offer a leaf from my own limited experience, which may help others as it has helped me.

Some years since I purchased from an "Economic Gas Engine Co.," in New York, one of their engines, for driving an ancient foot lathe, long in my family. It (the lathe) was built by Lukens about 1824.

The machine by dynamometer proved to have just one-quarter horse-power, but that for a good while it gave. Then it began to start with difficulty, and sometimes to stop. Much study not skilled was given to it. The ignition was by a vertical thin jet of gas, passing close behind the ignition aperture in the bottom end of the horizontal cylinder. This jet passed also through a vertical cylindrical coil of fine platinum wire, which, when the force of the explosion at ignition of charge extinguished the jet, becoming incandescent, re-lighted it. Sometimes the coil re-lighted the jet too late, and one or more revolutions were lost, causing irregularity, but, as things went from bad to worse, at last the machine declined to work at all. I got new platinum coils and they would work for a short time sometimes, and sometimes not at all.

I think the trouble was that the force of the explosion within the coil deformed it, so that, at a soft red heat, it sunk down and did not get the full heat of the jet of flame. At last, in despair, I tried the use of a second similar jet from one of the orifices of a fish-tail burner, stopping one of the two holes which are used in this form of gas burner. This jet was placed at the upper edge of the cylinder, as much as possible out of the sphere of the explosion from the igniting or touch-hole, and so arranged as to cross the original igniting jet above the touch-hole. It has proved a success, and has been in use for months, never failing to start at once and to keep the machine in action as long as wanted. When, as is often the case, the igniting jet proper is blown out, that stream of gas immediately resumes its course, and the upper jet, never being extinguished, at once re-lights it ready for the next revolution.

The gas engine is one having an explosion at every alternate outward stroke or revolution, and the machine runs at 332 revolutions per minute. The second jet uses about three to five cubic feet of gas per hour, which is a cheap remedy for the bother I had before I put the contrivance in action. With a larger, five or ten or fifty horse-power engine, the gas thus used would still be only one-half of the consumption of a five or six foot fish-tail gas burner.

The writer in *Engineering* states that, after difficulties much like mine, with incandescent cylinder and coil ignition, and with electric spark ignition, resort was had to a continuous stream of electric sparks. This is probably more expensive and troublesome to rig up than the second, or re lighting gas jet herein described. M. C. MEIGS.

Washington, D. C.

A Short Talk About Engineers.

Editor American Machinist:

It has often been asked, "What position does an engineer in a shop occupy among his fellow-workmen?" This question has never been satisfactorily answered.

In one of the morning newspapers there appeared quite lately the following advertisement: "A licensed engineer wishes a situation; is handy with tools; can do his own repairs, also pipe fitting. Would be willing to make himself generally useful, or take a position as janitor." Now, just as long as such persons as the above advertiser are on the market, to dispose of their valuable and accommodating labor, just so long will the man whose services are really desirable, find his condition unsatisfactory. No matter how mean the goods or services, a purchaser can be found; there are a class of people who deal in such wares; there is a chance to do some *saving*. No genuine engineer, who does some thinking, who endeavors to master some of the problems of steam engineering, would be willing to degrade himself so far as to be made a kind of foot-ball of, to be made to feel as if he was not of much consequence anyhow. Whether he is or not, if the man can be dispensed with, some one must succeed him; the position cannot be wiped out. The engineer's labor is just as necessary as that of any other person connected with the establishment. Failure or incompetency of the engineer affects the output, or, perhaps more correctly speaking, the profits of an establishment more, than in the case of any other working hand about the place.

Just what capabilities a so-called competent engineer should possess, would be more difficult to enumerate than those he should not. He must have good health, and steady habits are indispensable; sooner or later the former will be tested, and the latter must always be in stock. The engineer, like the physician, must always be qualified for business. If there is any other occupation which requires a partial knowledge of as many vocations as the engineer, it is not remembered just now. It takes a wide range, even from taking an indicator card to fixing a water-closet. In other occupations the workman sticks to his line. The rat-trap maker will do nothing but make rat-traps, and the mouse-trap maker will make nothing but mouse-traps.

More or less trouble is often experienced in procuring assistance in the engineer's department. Whenever the time arrives to make a general cleaning up, such as cleaning boilers, flues and kindred work, those who refuse to assist would be the first to condemn the engineer, should they lose an hour's work, or their lives be endangered. Really, the engineer, so far as safety is concerned, is little, if any, more affected than any other person employed in the establishment; all are equally interested in the safety and general good condition of the place where they earn their living; nor is it always fair that the same persons should be called on to do, in all probability, the hardest and dirtiest work ever done about the locality. It would, however, often be much to the advantage of the engineer, could he always have the same persons to assist him at such times, for they would become trained to the business, and thereby relieve him to a certain extent, leaving him comparatively free to attend to other matters claiming his attention. He alone will be held responsible for both time and the manner in which the work is done. WM. J. WILLIAMS.

Mechanical Reference Books.

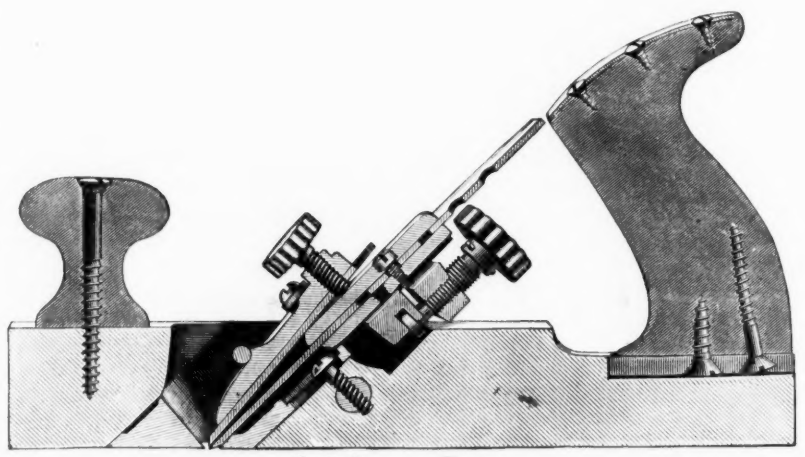
Editor American Machinist:

Having occasion recently to find what thickness a cast-iron plate would have to be to withstand 100 lbs. steam pressure per square inch with safety, I referred to Haswell and Nystrom, but not finding any rule in either that was directly suitable for the case, I then looked in "Relative Proportions of the Steam Engine," by W. D. Marks, and there I found two rules which gave such widely different results, that I think it best to call attention to them, with the hope that future editions of this excellent book will be revised somewhat in that particular part.

The first rule is in Art. V, Chap. 1, with the following text in explanation: "In considering rectangular plane surfaces subjected to fluid pressure in Weisbach's "Mechanics of Engineering," the following formula is deduced for square plane surfaces, which will, of course be, with greater safety, true for a circular inscribed surface:

Let T=the thickness in inches of plate.
" P=pressure in pounds per square inch.
" D=diameter of plate.

$$T = 0.003\, D \sqrt{P}.$$



SELF-SETTING PLANE.

The other rule is in Art. VIII, Chap. 2, and is for steam chest covers, as follows:

L = longest inside measurement of chest in inches.
B = breadth of chest in inches.
P = pressure in pounds per square inch.
T = required thickness of cover in inches.

$$T = \frac{L^2\, B \sqrt{P}}{60\, L^4 + B^4}$$

The following example is worked out by the above:

Let $L = 40''$; $B = 20''$; $P = 81$ pounds. Then $T = 3''$.

Now working out the same example by the first formula given—except that we will assume the chest to be $40'' \times 40''$, which would be double the area of the given example, we have the following:

$$0.003 \times 40'' \times 9 = 1.08'',$$

only a little over one-third as thick a plate to withstand double the amount of pressure. Is it any wonder that practical mechanics sometimes ridicule reference books? In regard to the second formula it is evidently not correct, because the length of the chest is made a factor, and that would not need to be considered unless it was held by bolts at the ends only. In considering the thickness of a cover for a rectangular chest, on which the cover is fastened by bolts placed equidistant along the edges, the length is not a factor, and the calculation could be made with correctness by considering one inch of the length by the breadth; being equivalent to a beam fixed at the ends and uniformly loaded between supports. As to the first formula, I would fear that a cover 1.08" thick for a 40" x 40" chest would not be very safe.

Pittsburgh, Pa. A. RANDOLPH.

Rapid Trans-Atlantic Traveling.

The "City of Paris," the Inman line racer, has "broken the record" again—this time her own record. Her time from Queenstown to New York was 5 days, 19 hours and 18 minutes; and the distance run was 2,788 miles. This gives an average speed of just a trifle more than 20 miles an hour, or better than 23 miles as miles are reckoned on land; it is certainly a wonderful performance, made possible only by the steady advance of engineering skill and science.

In the early days of trans-Atlantic steamships, if the time made by the "City of Paris" had been prophesied by one who knew anything about the matter, he would have been set down as a harmless lunatic. Even only a few years ago such speed was thought, to say the least, impracticable, for it was understood how enormously the power must be increased to nearly double the speed of a steamship. The possibilities of high-pressure steam, and a better understanding of how to use it, have wrought a remarkable change.

Of course, only the steamship companies know whether or not such speed is profitable; but, having shown the possibility of it, it will not be easy, except by concerted action, to go back to more moderate speeds. The effort will now be to beat the "City of Paris," and that will undoubtedly be accomplished by some other of the great lines; no one can tell where it will end. If a man were to predict the speed of an express train for one of these enormous steamships, he would hardly be laughed at. It is unsafe to say the limit is reached, for that has been said a half dozen times before, when the speed was much slower. This is a fast age, and speed in traveling seems to be called for above everything.

It is sometimes said that such speed is dangerous; for, if a vessel struck an iceberg, or collided with another vessel, she must be destroyed. But suppose the speed was no more than 15 miles, would not the result be about as disastrous? At least, a steamship making 20 miles an hour is exposed to danger less days in crossing the Atlantic than one that makes but 15.

The New York *Times* outlines a scheme thus early for bleeding the patrons of the great fair that is to be. It says, after arguing that Philadelphians did not know how to do this in 1876:

"It ought to be worth a quarter of a million merely to sell food and drink to ten million people who cannot choose where they will buy, but must pay their money over the counters on the spot, or pay another admission fee."

Plainly stated, the project of the *Times* is that, after paying a good round price for what they eat and drink, those who are so unfortunate as to be obliged to patronize the restaurants on the ground shall be compelled to contribute "a quarter of a million"—to stand and deliver as it were. Why not cut the Gordian knot of finance by charging enough for the privileges of selling food and drink to cover the entire expenses of the fair? It is only necessary to assume that there is no limit to the extent to which it is possible to victimize people. If only a few conclude, under the circumstances, to refresh themselves on the ground, all that will be necessary to do is to victimize them in inverse ratio to their number. If people are kept from visiting the fair by exorbitant charges the expenses will be assured just the same. It is a great scheme.

The lunatic who made the last effort to cross the Atlantic in a small boat has been picked up in an exhausted condition, after being at sea since July 3d. He made the experiment with an eighteen-foot boat. If he recovers he will not, probably, repeat the experiment.

It is said that platinum can be soldered to gold by first sweating some fine gold into the platinum at a high heat. The gold soaks into the platinum, then solder will adhere to it.

Twenty-Inch Post Drill—Twenty-eight-Inch Upright Drill.

The engravings represent two drills, brought out from new patterns by J. E. Snyder (successor to Currier & Snyder), Worcester, Mass.

The post drill has sliding head, quick return, and lever feed, though wheel feed will be substituted when desired. It is designed more particularly for blacksmiths and carriage makers.

The sliding head has a vertical movement of 18 inches, and can be quickly placed in any position on the face of the post by means of the quick-return lever.

The bearing on spindle is 1½ inch diameter; the hole in spindle conforms to the Morse taper. The cones are 5 inches, 7 inches, 9 inches and 11 inches in diameter, with 2½-inch face. A countershaft with pulleys 12″x 3″ goes with the machine.

The 28-inch drill is back-geared, and has power feed. By means of quick return in connection with rack and pinion, the sliding head can be very quickly raised or lowered. The vertical movement of the sliding head is 27 inches. The spindle is made of crucible steel, the hole being Morse taper No. 4. The bearing on the spindle in head is 1¾ inch diameter. The cone pulleys are 6 inches, 8 inches, 10 inches and 12 inches in diameter, with 3-inch face. The counter pulleys are 13″x4″.

The automatic feed is obtained by means of friction gear and worm, in connection with bevel gears driven by cone on the top shaft.

The greatest distance between the base and spindle is 54 inches; between spindle and face plate, 35 inches. The arm which swings around the column has a vertical movement of 17 inches. The total weight of drill is 2,300 pounds.

The deputation of American mechanics who have recently started on a brief tour through Europe, seem to have no difficulty in gaining admittance to the more important engineering establishments and iron and brass foundries in the various industrial centers which they are now visiting for the purpose of increasing their knowledge of things relating to their professions; they also make themselves acquainted with the social condition of the people in the towns they visit. It is reported that, from casual observation dropped at the dinner at the Tavistock Hotel, that they think the output per man in America is greater than in England. The ladies of the deputation are reported to have been much shocked by their visit to the chain-making districts of Staffordshire. They had no conception of the kind of work performed by women in that part of England. The officers of the various trade unions in the iron trades have been devoting some time to the members of the deputation.

Common Sense at Last.

In an excellent article on the fast run of the "City of Paris," *The Sun* says:

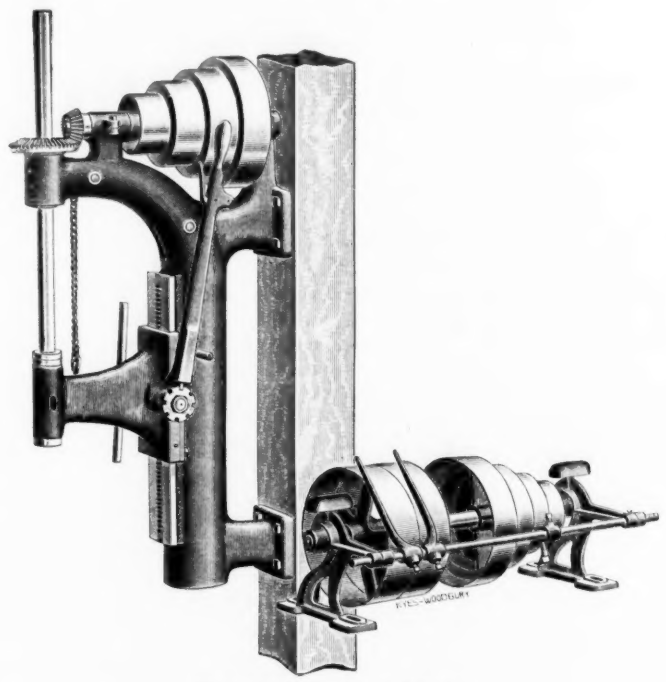
"It is likely that the man who was most delighted with the result of the trip was the man who was responsible for the speed attained. He didn't get any letters from the passengers, but he got congratulations a plenty from men whose appreciation was worth something to him. He was Chief Engineer Wall. In the old days of sails the post of responsibility was the quarter-deck; in these days, when the latest ships carry no yards at all, and are driven by twin screws, the post of responsibility is at the throttle valve."

This is true in the main. But in these fast runs it is safe to say the throttle valve isn't fooled with to any great extent.

The *Boston Transcript* speaks feelingly of the fact that the average man is all at sea when he tries to find out something about the movement of trains from the usual railroad guide. Some one with the necessary genius ought to set his wits at work getting up an intelligible time-table for the men who publish railroad guides, so-called.

Drop Forgings.

Locomotive works are realizing the fact that drop forgings are cheaper and better than those made in the ordinary way. Take, for instance, a reach rod jaw; blacksmiths often receive fifty cents for making one in the ordinary way, and under a drop they can be made for $10 to $12 a hundred. Another advantage of drop forgings is that they can be made nearer to the finished size, thereby saving considerable labor in the machine shop. Several locomotive shops now use drop hammers for their small forgings, and the tendency is to make some of the larger forgings in the same way.



TWENTY-INCH POST DRILL.

TWENTY-EIGHT-INCH UPRIGHT DRILL.

Electric lighting is very far from making the progress in Europe that it has made in America, but it has had the effect there of vastly improving lighting by gas. By improving gas-lights in the large cities of Europe, the gas companies have put electric lighting back some years. Here, when electric lights gain a foothold, the gas companies attempt to compete by giving poorer lights, and increasing the cost.

According to English reports, the railway companies are just now good customers for stores and carriage fittings; and government orders for dockyard supplies, tools, metal and machinery, as well as ammunition, are on a large scale.

Computing the Mean Pressure of Expanding Steam.

In estimating the power of a steam engine at different points of cut-off, it is customary to use a table of hyperbolic logarithms, the process being well known to engineers. The table given below will be found to greatly simplify the operation as compared with the use of the table of logarithms. It is taken, by permission, from *The Tabor Indicator*, by John Musgrave & Sons, Bolton, England. To use the table, multiply the *constant* opposite the point of cut-off selected, by the total pressure of steam (that is, the pressure above vacuum,) and the product will be the *total* average pressure of steam for the whole stroke. From this must be subtracted the back pressure, say 16 lbs. for a non condensing engine, and 5 lbs. for a condensing engine.

The following example will make the operation plain to those not accustomed to such calculations: Suppose we are to use steam of 75 lbs. boiler pressure, and wish to cut off at 20 per cent. = ⅕ of the stroke of the piston. To get the *total* steam pressure add 15 (which is near enough the pressure of the atmosphere for this purpose) to 75, making 90. Opposite 20% in the table is found the decimal .5219; this multiplied by 90 gives 46.97+. For a non-condensing engine subtract 16, which leaves 30.97 lbs. as the mean effective pressure on the piston. If the engine is condensing, subtract 5 lbs., which leaves the mean effective pressure 41.97 lbs.

CONSTANTS FOR FINDING THE AVERAGE PRESSURE IN THE CYLINDER WITH ANY PRESSURE OF STEAM.

Percentage of the stroke at which steam is cut off.	Constant.	Percentage of the stroke at which steam is cut off.	Constant.
1%	.0560	41%	.7758
2	.0982	42	.7841
3	.1321	43	.7920
4	.1688	44	.8010
5	.1998	45	.8088
6	.2288	46	.8164
7	.2563	47	.8235
8	.2821	48	.8318
9	.3067	49	.8396
10	.3302	50	.8466
11	.3527	51	.8536
12	.3743	52	.8592
13	.3952	53	.8660
14	.4152	54	.8722
15	.4345	55	.8779
16	.4532	56	.8846
17	.4712	57	.8904
18	.4885	58	.8962
19	.5055	59	.9002
20	.5219	60	.9062
21	.5377	61	.9114
22	.5529	62	.9162
23	.5679	63	.9200
24	.5823	64	.9264
25	.5967	65	.9298
26	.6102	66	.9340
27	.6237	67	.9385
28	.6365	68	.9427
29	.6484	69	.9461
30	.6612	70	.9496
31	.6726	71	.9531
32	.6842	72	.9588
33	.6958	73	.9595
34	.7066	74	.9620
35	.7172	75	.9638
36	.7276	80	.9784
37	.7378	85	.9878
38	.7477	90	.9945
39	.7567	95	.9960
40	.7665	100	1.0000

In a recent issue of the AMERICAN MACHINIST, our correspondent at Paris referred to the exhibit of Stiles & Parker as having no one in attendance. Mr. Stiles calls to inform us that the exhibit is now in complete running order, and three attendants are ready to show the working of their machinery. As a souvenir, Messrs. Stiles & Parker are making, at Paris, an elegantly finished pocket knife; the blades of this knife open by means of a spring, which is released by a touch of the thumb. It will serve as a very useful remembrance of the great Exposition.

We learn that the class in steam engineering at the Young Men's Institute, 222 and 224 Bowery, will open on the first Wednesday in October. Application should be made at once at the Institute. Sessions will be held two evenings a week—Wednesdays and Fridays, from October to May, 1890.

The velocipede is hereafter to be part of the equipment of the French army. Every infantry regiment is to have four.

AMERICAN MACHINIST

To prevent delays all Communications should be addressed to the Company.

PUBLISHED WEEKLY

BY

American Machinist Publishing Co.

96 Fulton Street, New York.

HORACE B. MILLER, Pres't and Bus. Manager.
LYCURGUS B. MOORE, Treas. and Sec'y.

F. F. HEMENWAY, Editor and Mech. Engineer.
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$3.50 a year to Other Countries, postage prepaid.

Advertising.

Transient, 35c. per line, each insertion.
"Business Specials," 50c. a line.

The American News Company,
Publishers' Agents, New York.
The International News Company,
11 BOUVERIE STREET, Fleet Street, LONDON, ENG., will receive subscriptions for the AMERICAN MACHINIST, at 14/7 per annum, postage paid.

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NEW YORK, SEPTEMBER 5, 1889.

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A Good Suggestion.

About the most sensible and practicable suggestions so far offered in relation to the World's Fair to be held in 1892, which we have as yet noticed, come from Mr. Edward Atkinson, of Boston, who, among other things, says:

The day has gone by for a grand World's Fair or bazaar in which all kinds of goods and wares may be displayed, largely for purposes of advertising them, without much system or method, and without any distinctive purpose in the general scope or plan of the exhibition, except to make a great "show."

He declares that better shows of that character can be found in the shop windows, and that while the time was when such fairs were interesting and instructive, they are now "cumbrous, costly, tiresome, and unsatisfactory." He also virtually declares that the system of giving diplomas should be relegated into desuetude, that they have in the past been given substantially to everybody, and when an exhibitor was refused he appealed to the higher powers and obtained his diploma or certificate of excellence. We all know that there is much truth in this, and that the value and significance of certificates, diplomas and medals have been very much depreciated in consequence of the ease and certainty with which nearly every exhibitor has in the past obtained something or other which seemed to afford him tolerably good grounds for the assertion that his particular exhibit was the very best of its kind.

Mr. Atkinson proposes in place of this to have an exhibition which shall show by models, specimens, pictures, figures, machinery in operation, etc., the development and progress made in all branches of industry and art since the discovery of this continent in 1492. We think the suggestion is an excellent one, and that some such plan is far preferable to making an effort simply to get together a greater number of miscellaneous articles contained in buildings covering more acres of ground than have been reached by any previous exhibition. By all means let there be an effort to attain some degree of originality. The mere massing together of vast quantities of goods, exhibited without much reference to each other, where the sole object of the management is to have the biggest show to date, and of each exhibitor to attract more attention to his particular exhibit than his neighbors and competitors are able to attract, has been carried about far enough, and there is an excellent opportunity now for Americans to make the exhibition of 1892 memorable as marking a new and more rational epoch in the history of fairs.

Do It Well.

There is a world of philosophy in the words of the Kansas minister who said: "I have been a far more useful man since the Lord revealed to me that I was never to be a great man." There are some mechanics, whose own opinion that they are, or are to be great in the mechanical world, is preventing them from being really useful, and attaining that degree of success to which their actual abilities would otherwise entitle them. By keeping their imaginary greatness constantly before their eyes, they put themselves into such a condition as to effectually shut out the possibility of real greatness. Whatever else may have contributed to it, we believe real greatness has never yet been attained, except by doing that which came to hand in the best possible manner. And it is just that thing, that he who imagines himself to be great by destiny, fails to do. Of course, it does not follow from this that all who diligently and quietly make the best possible use of their opportunities will become great; for greatness is only relative, and all men cannot be great, any more than the entire surface of the earth can be composed of mountain tops. But he who dismisses from his mind all idea of natural or predestined greatness, and simply devotes all his powers to the doing of that which comes to hand in the best possible manner, has the best possible chance of becoming great, and whether he becomes great or not, will have the satisfaction of having done full justice to himself, while he who neglects the faithful performance of the small duties of life as they present themselves, because he imagines he was created for greater things, is sure to find himself left behind, and that the only person in all the world who places a high estimate upon him, is himself. We do not address these remarks to mechanics because we think they may profit by them more than others, for the principle applies equally well to all men, of course. But mechanics, as well as others, need constantly to remember that he who over-estimates his ability, deceives himself only.

Of course, the opposite error of thinking oneself incapable of things which, by a little effort, may easily be accomplished, is to be avoided as well, and it is undoubtedly best, upon the whole, to do very little thinking about one's own abilities, either to over or under-estimate them, but simply to put forth the full strength to the doing of that which seems best to be done at the time, leaving the future to decide whether greatness shall or shall not be attained, and philosophically accepting the result.

At the expense of being called superstitious, a good many people will insist about this time that railroad accidents come in bunches, as it were, and swing around in cycles. During the past few weeks three or four collisions—or other accidents—a day has been the record. There may be a reason for the intermittent character of railroad accidents, not always thought of by those who notice the fact. General freedom from mishaps may induce carelessness even in the instance of railroad men, the result being the recurring crop of smashups. This, in turn, stirs them up to intense carefulness, the opposite condition prevails again, and the cycle is complete.

The French army evidently has some excellent engineer corps in its organization. Recently an experimental military steel bridge was erected over the river Var, the stream being 735 yards wide. Work began at noon, and in forty-eight hours artillery was passing over the bridge, although most of the work was done during a severe storm. In the morning of the day upon which work began there was none of the material on the ground. The material is so got out as to be adjustable for streams of different widths.

Sails have recently won a victory over steam. A United States revenue cutter appears to have been fairly beaten by a sealing schooner in a chase of five or six hours. It is not quite certain whether the victory of the schooner was due to her good sailing qualities or to the poor steaming qualities of the cutter. Uncle Sam is in possession of some venerable steam crafts that would apparently get along better with a sailing vessel to help.

Literary Notes.

PRACTICAL BLACKSMITHING. Compiled and edited by M. T. Richardson Illustrated. M. T. Richardson, New York, Publisher.

This book consists chiefly of articles contributed by practical men to the *Blacksmith and Wheelwright*, and for this reason the matter will be found superior to anything written on the subject by those who write from theory. It is just such a book as the needs of the trade demand, and it seems strange that, while other trades are liberally supplied with practical works relating to their vocations, the blacksmith has been left out. The book has 224 pages, and sells for one dollar.

We have received from J. F. Holloway, of New York, a printed copy of a lecture on "Pumping Machinery," delivered by him before the students of Sibley College. In addition to a good deal of instructive and interesting information regarding means of raising water—ancient and modern—there is a very clear exposition (with illustrations) of the operation of the compensating cylinders of the Worthington high-duty pumping engine.

Questions and Answers

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(329) T. P. Abbott, of New York, sends us a question to which he requests an answer by mail, but gives an address from which the letter is returned. Correspondents should be careful to give their correct address, plainly written.

(330) E. J., St. Louis, Mo., asks: What is the customary or correct way of ordering flat iron or steel? I am in the habit of giving the thickness first, ¼x3—½x2, etc., but I find that many blacksmiths give the width first, as 3x¼—2x½, etc. Which is right or most sanctioned by custom? *A.*—We believe your way is much the most general, though we do not know that either can be called right and the other wrong. Practically, there is little difference. The same iron would be delivered in either case.

(331) R. S., Chicago, asks: 1. Why does wrought-iron rust quicker than cast-iron under the same circumstances? *A.*—It don't. Cast-iron almost invariably rusts first. 2. What is "kalamein," and are tubes made of kalamein preferable to cast-iron pipes for water transmission? *A.*—We do not know just what kalamein is, but it is an alloy produced by the amalgamation of several non-corrosive metals. Its action upon iron is to fill the pores and resist corrosive action. It is recommended for gas and water service pipes.

(332) "Subscriber," ———, writes: Will you please inform me how to clean greasy cotton waste? *A.*—The grease can be extracted from it by boiling in water in which sal-soda has been dissolved, at the same time keeping the contents of the kettle in motion, in order to wash out the grease. It has never been found to pay very well, however, as the waste is not nearly so good as before, and, when compared with new waste, is hardly worth the cost of cleaning it. One of the things which make it objectionable is the presence of chips of iron and other metals which remain in it if it has been used in a machine shop.

(333) F. D. M., ———, asks: 1. If a man has a patent on a piece of machinery, can another man make the same machine for his own use without infringing upon the patentee's rights? *A.*—No, not generally speaking, though we believe the making of a patented machine by one who makes it simply for the purpose of experimenting with a view to its improvement is allowed. 2. What is the benefit of a siphon on a steam gauge? We are running one here with a straight pipe, and it seems to work all right. *A.*—The object of the siphon, as it is called, is to prevent heating of the gauge by steam getting into the tube. The lower part of the pipe fills with water condensed from the steam, and thus prevents the steam passing into the tube of the gauge and heating it.

(334) F. W. R., ———, asks: 1. How are re mers ground so as to be exactly the right size, and taper reamers the right taper? *A.*—Reamers are usually ground upon centers, using micrometer or other gauges for determining the size. Taper reamers are often fitted to gauges called receivers, which have holes in them of the right taper. In the absence of such things, they may be measured by micrometer or vernier gauges at points a definite distance apart. 2. How may taps be hardened to prevent liability of cracking, and how kept bright so that repolishing will be unnecessary? *A.*—They cannot be hardened so as to prevent all liability of cracking, but the liability can be much reduced by proper selection of steel, after which it is a matter of care and skill in heating. We know of no way of keeping them bright that is a satisfactory substitute for polishing in the grooves if the temper is to be drawn, though by practice the art of heating them to the right temperature, so that they require no subsequent drawing, can be acquired.

(335) J. S., Philadelphia, Pa., writes: I have been told that, in order to test a boiler I should fill it with water, so that the water flows out of the safety valve; then shut this valve and start a fire under the boiler, and raise the pressure up to the point at which I wish to test it. Is there any danger in testing a boiler in this way? *A.*—Boilers are sometimes tested as you describe, but we do not believe it to be as good as the following way: Close all the openings in the boiler as securely as possible, but keep the safety valve open until the boiler is completely filled with water. Then, after closing the safety valve and loading it to the required test pressure, raise the pressure by means of a pump till the steam gauge indicates the test pressure. The pump should only deliver a small quantity of water at each stroke, and must be worked carefully as the pressure rises, in order to avoid jarring the strained boiler, and producing a

sudden rise of pressure beyond the limit of test pressure. Some engineers close the safety valve before the boiler is quite full of water, and so retain a quantity of air to act as a cushion when the pressure is applied by the pump; but the objection to the enclosed air is, that when it escapes through leaky seams and rivets, no marks indicating such leaks are indicated on the plates. When boilers are tested by hydrostatic pressure, the water should always be hot.

(336) Vermont, ——, writes: Will you kindly answer the following question and settle a dispute between an engineer and a boiler maker? There are two boilers, 14 feet long, 48 inches diameter, each containing 50 flues 3 inches diameter; the boilers have been used 18 years, and now, in putting in new flues, I claim they should be beaded on both ends, as it will strengthen the heads; also, the tubes will last longer. The boiler pressure is 75 pounds. On the other hand, the boiler maker claims that it is nonsense to bead the flues, as they are better and stronger when not beaded. Who is right? *A.*—We do not see any necessity for beading the tubes in a plain tububar boiler; tubes which are simply expanded have a holding power in excess of the stress due to a steam pressure of 75 pounds, upon the portion of the tube sheet which any tube will have to support. In a fire-box boiler, we should prefer to bead the ends of the tubes exposed to the heat and flame, thereby protecting the ends, and preventing them from wearing and burning away too rapidly. On the other hand, it is not true that a tube not beaded is stronger than the one that is beaded, as the boiler maker claims. Experiments recorded in the "Treatise on Steam Boilers," by W. H. Shock, show that an iron tube 2¼ inches diameter, simply expanded by the Dudgeon tool, in a ¾-inch plate, resisted a mean pressure of 6,750 pounds; and another tube of the same size, expanded in the same way as the former, and with the ends beaded, resisted a mean pressure of 19,450 pounds. One objection to beaded tubes is that they cannot be removed as readily as those which are not beaded.

(337) C. S. P., Conneaut, O., writes: I own a two-sparred yacht, 30 feet long, 8½ beam. It is a good sailer and seaworthy. She is in use every day on Lake Erie and Conneaut River, but I have five miles each way to traverse on the narrow and crooked river, and few are the days when much hard rowing is not required on it, and frequently, also, at this season of the year, when I get becalmed on the lake. This feature of the business is so hard and exhausting as to rob much of the pleasure of yachting. Now, I am very seriously contemplating the plan of taking out the stern spar and sail, and putting in its place a four or six horse-power marine engine and propeller, retaining the foresail in her. To the plan of putting in an engine there is first and greatest, the objection that the government regulations will compel me to keep employed a licensed engineer to run the engine, provided it is a steam engine. This objection alone is sufficient to deter me from doing so; but the local inspectors of steam craft inform me that I can put in a naphtha or oil engine operating by explosions, and no engineer will be required. This is what I would like to do, but having no reliable information as to the good practical working qualities of such engines, I have decided to bore you on the subject, with a view to acquiring some reliable information. 1. Will it be practicable to put such an engine in such a boat? 2. Are there reliable naphtha or oil marine engines, working by explosions without steam manufactured? *A.*—We believe that the naphtha engine, built by the Gas Engine & Power Co., New York City, will answer your purpose. This engine is not worked by explosions, but by a gas generated from the naphtha. We should advise you to write to the above firm. A licensed engineer for running this engine is not required.

(338) W. A., Orange Valley, N. J., writes: Enclosed please find sketch of a plan we had to heat the water for working out our hats. We made a coil of pipe with return bends 6 feet long and 1½ inches diameter, and placed it back of the bridge wall. The level of the water in the tank is about 14 feet higher than the outlet of the coil, and when we connected the coil, the water would not run through the outlet. I was going to have it connected to a pipe marked *X X*. When we found the water would not run out, I connected a ¾-inch hose to the hydrant, and thus obtained water at a pressure of 51 pounds to the square inch, and this water flowed through the coil all right. Please tell me why the water from the tank will not flow through the coil; and how we can fix the coil so that we can use the water out of the tank; this water is from a well, pumped into the tank. I cannot see why water will not find its level; it is a puzzle to me. *A.*—The reason for the unsatisfactory results of your arrangement is that the tank is not placed high enough to give a sufficient pressure for overcoming the friction in the coil and pipes. A head of 14 feet gives a pressure of only about 6 pounds to the square inch, which, considering the number of bends, is too small for results of any practical value. Place the tank higher, so as to increase the pressure; how much higher the tank should be placed we cannot say, since you do not give the radius of the bends and elbows, and the length of the pipe running in a horizontal direction. Connecting the pipe marked *X X*, as shown in your sketch, will not work under any circumstance, because you will have equal pressures at each end of the coil. Our advice is to call in a first-class engineer, and let him make the necessary calculation and design. Coils at the back of a bridge wall are dangerous things to experiment with.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Gear wheels and g-cutting. Grant, see adv., p. 16.

Link-Belting and Sprocket Wheels.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Engineering Co., Philadelphia and N. Y.

25″ Upright Drills. J. E. Snyder, Worcester, Mass.

28″ Upright Drills. J. E. Snyder, Worcester, Mass.

32″ Upright Drills. J. E. Snyder, Worcester, Mass.

36″ Upright Drills. J. E. Snyder, Worcester, Mass.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

The Improved Justice Hammer. Williams, White & Co., Moline, Ill., manufacturers.

R. Dudgeon, 24 Columbia st., New York. Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton & Dutch sts., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

Ice and Refrigerating Machines, 131 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

Bit Brass Die Holders, and Bit Brass Taps. S. W. Card & Co., Mansfield, Mass.

"How to Keep Boilers Clean." A 96-page book mailed free by Jas. E. Hotchkiss, 120 Liberty st., N. Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Best silk wiping towels for machinery in the market. S. A Smith, 23 S. Canal st., Chicago, Ill.

Iron Planers from 16″ to 36″ wide by any length. H. C. Pease & Co., Worcester, Mass.

R. G. Du Bois, 715 11th St., Washington, D. C. Procures first class patents on inventions. Write.

For the latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Send $1 for Catalogue D, Fine Tools and Supplies. Over 550 pages. Fully illust'd. Free when $10 worth goods are ordered. Frasse & Co., 92 Park Row, N. Y.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See Aug. 29, p. 10. Send for circular No 17. Curtis Reg. Co., Boston, Mass.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

For Portable Key-seating Machines and Stub Ends for small connections, address T. C. Dill Machine Co., 726 Girard ave., Philadelphia, Pa.

The best emery wheel made is the "Norwich." For particulars send to Montgomery & Co., 105 Fulton st., New York.

Rubber Belting, all sizes, 77½ per cent. from regular list. All kinds of Rubber Goods at low prices. John W. Buckley, 156 South street, New York.

The Holly Manufacturing Company, of Lockport, N. Y., will send, on application, their pamphlet illustrating pumping machinery and reports of duty trials.

W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches, working drawings for the transmission of power by steam, water, air and electricity.

Steam Boilers: Their management and working on land and sea. By Jas. Peattie. Practical facts from 30 years' experience. 230 pages illustrated, 12mo., cloth, $2. Circulars and Catalogue of Books for engineers free. E. & F. N. Spon, 12 Cortlandt st., N. Y.

For foundry or general manufacturing, a compact property in heart of Buffalo, N. Y. 98x380 ft., on two streets, near canal and R. R. Steam heated brick building ⅓ size of lot, four light, clear floors, two elevators, outside stairs, engine, boiler, main shafting, wagon scales, stables, abundant yard room. For sale cheap. Address M. H., 56 Pearl St., Buffalo.

H. B. Roelker, 22 Cortlandt st., New York, late Sup't Delamater Iron Works, will hereafter manufacture the Delamater Screw Propeller.
Propellers of same pattern and workmanship as formerly made by the Delamater Iron Works. Each designed for its special work at lowest prices.
Consulting Expert and Constructing Engineer.
Estimates made on machinery and on damages.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G Co., 96 Fulton st., New York.

C. H. De Lamater & Co., New York, have for sale a very desirable lot of machinery and fixtures for Pattern Makers, Brass Founders, Machinists, Riggers, Blacksmiths and Boiler Makers; also stock of boiler iron, plate iron, sheet iron, patterns and pattern lumber, sand and clay, pipe and pipe fittings, shafting, hangers, iron and wood pulleys, belting, bolts, nuts, washers, screws, nails, packing, flasks, and the necessary small tools for iron and brass founders.

"Practical Drawing." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including August 29, 1889 issue, 84 articles have been so far published. Copies containing these articles sent by mail to any part of this country or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING Co., 96 Fulton st., New York.

"Modern Locomotive Construction." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 98 articles have thus far appeared up to and including the August 22, 1889 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada, at 5 cents each. AMERICAN MACHINIST PUBLISHING Co., 96 Fulton st., New York.

MANUFACTURES

A planing mill is to be built at South Sioux Falls, D. T.

The Capital City oatmeal mill at Des Moines, Ia., is now being built.

Gilbert Brandeth will build a sash and door factory at Murphy, N. C.

A knitting mill, to manufacture socks and mittens, will be built at Lansing, Mich., at a cost of $10,000.

The Union Electric Light and Power Co. has been organized at Skowhegan, Maine. S. W. Gould is president.

It is reported that a flouring mill is to be built at Ulen, Minn., by the farmers of that locality, on the co-operative plan.

The Knowles Steam Pump Works, of Warren, Mass., propose to enlarge their shop, and the work will begin at once.

A. A. Foster, Racine, Wis., whose box factory and planing mill was wrecked by a boiler explosion several months ago, is now rebuilding

Pierce Ryan, of Worcester, Mass., is building an addition to his dye-house. When finished, it will be 42 feet broad, and 59 feet long, and three stories high.

The stockholders of the Palmer Carpet Company, of Palmer, Mass., have voted to increase the capital stock of the company from $50,000 to $100,000.

Merwin McKaig, Cumberland, Md., has issued a price list of turned and polished shafting, with a telegraph code for ordering. He is quite busy filling orders.

The Spokane Fuel Company, Spokane Falls, W. T., lately incorporated with a capital stock of $50,000, will include the manufacture and sale of lumber in its business.

There is water-works agitation at Pinckneyville, Ill.; Attalla, Ala.; Union City, Ky.; Union, S. C.; Metropolis, Ill.; Boscawen, N. H.; Cuero, Texas; Litchfield, Conn.; Huntington, Ind.

Edward and William Shipper, of Louisville, Ky., are building a saw mill on a 1,300-acre tract of land owned by their father on the Clarion River, Clarington, Pa. They will saw hemlock chiefly, filling in with pine, ash, cherry and beech.

The Glen Mills, of Fall River, Mass., have been incorporated, with a capital of $300,000, for the manufacture of cotton, silk, linen, flax or woolen goods; D. H. Dyer is the president, and Joseph McCreery the treasurer of the corporation.

A syndicate of English capitalists are negotiating for the purchase of the extensive woolen mills of James Lees & Sons, at Bridgeport, Conn. It is understood the syndicate will accede to the price named by the firm, which is said to be about $500,000. The mills employ about 700 hands.

All the machinery in the Hinckley Locomotive Works, Boston, Mass., has been sold, through the agency of Hill, Clarke & Co. About $65,000 worth was sold at private sale, and $25,000 worth at auction. The present buildings will be demolished, to make room for an electrical plant by the West End Railway Co.

The Illinois Steel Company, of Chicago, have leased the Mayville furnace, at Mayville, Wis., from the Northwestern Iron Company. The furnace is out of blast, but it is the intention of the lessees to blow it in as soon as possible. Its capacity is about 1,500 tons a month, and it may be utilized for either foundry or Bessemer iron.

The Wilmot & Hobbs Mfg. Co., of Bridgeport, Conn., are putting in an electric light plant of 250 lamp power, and expect soon to run their works 23 hours per day. This firm is reported exceedingly busy in cold rolling of steel, manufacture of light and heavy press, and drop and draw bench work made from steel, copper and brass.

James Hunter & Son, North Adams, Mass., send us their latest illustrated catalogue of friction clutch pulleys, cut-off couplings, hangers, pulleys and shafting, and other machinery. Illustrations show various applications of their devices. The catalogue contains description of their frictions, directions for ordering, price list, and some excellent rules.

A Jefferson (Texas) dispatch says: The first consignment of machinery for the great Lone Star Iron Works arrived this morning. There was a great deal of talk about the company falling through, but this has set the thing moving. Before the first of January, 1890, Jefferson will have the largest iron works in the State of Texas. Already the contract for the burning of 2,000,000 brick for the furnace has been let.

Thomas McGraw, of Saginaw, and R. W. Hawley, of Cleveland, lumber capitalists, who own extensive pine lands in the northern part of the State, will commence the erection of a saw mill at the mouth of Dead River, two miles west of Marquette. The mill will have a capacity of 30,000,000 per annum, and will be ready for operation at the opening of next season. Surveys are under way for a line of railroad from the mill to the timber lands, which lie along Dead River, ten miles distant.

The Standard Planing Mill and Manufacturing Company, Limited, has been incorporated at New Orleans, with a capital stock of $50,000, divided into 500 shares of $100 each. The board of directors are: H. C. Gause, president; John W. Adams, vice-president; Fred H. Oltmann, Octave Lagman and Chas. J. Gitz. They will conduct a general wood-working and planing business, including the manufacture and sale of sash, doors, blinds, and other building materials. They have already bought considerable machinery.

Owing to the death of Mr. D. Frisbie, president of The D. Frisbie Co., New Haven, Conn., on August 1st inst., the directors of the company held a meeting for the election of officers, with the following result: J. B. Scranton, president; C. F. Root, vice-president; W. M. Frisbie, secretary, and S. H. Barnum, treasurer. Mr. W. M. Frisbie will continue the New York office at 112 Liberty street, and will devote his whole attention to the placing of the goods manufactured by the company on the market. The company have very materially increased their facilities for turning out work, and say they are now able to fill all orders promptly, and at low prices.

A Boston dispatch says: At the annual meeting of the Calumet and Hecla Mining Company, Wednesday, 71,950 shares were represented. The old board of directors was re-elected, with the exception that F. L. Higginson was chosen to succeed George Higginson, deceased. President Agassiz, in his report, stated that the water supply was becoming low, and that a plan is under consideration to tunnel Lake Superior, and pump water from that source. The expense of sinking the new vertical shaft and the execution of the tunnel will be about $20,000 per month for the next three years. The company will next year put in two new engines on the southern part of the property.

Mr. E. D. Goodwin, manager of Chicago branch of Lodge, Davis & Co., informs us that, owing to the unexpected increase in their Chicago business since the opening of their store on March 1st, they have found their present quarters at Lake and Canal streets entirely too small to carry the necessary stock of machine tools. They have therefore secured the extra large double stores Nos. 68 and 70 South Canal street, near Madison, which will give them 7,000 feet of floor space, enabling them at all times to keep in stock a complete line of their improved machine tools, including engine lathes, shapers, planers, drill presses, radial drills, milling machinery, plain, back-geared and universal turret, Fox and speed lathes, and, in fact, all tools necessary for iron and brass-working outfits.

A company under the name of the American Pine Fiber Company has been organized and incorporated in Wilmington, N. C., for the manufacture of bagging, etc. The company has an authorized capital of one million dollars, and its officers are: President, Wm. Latimer; vice-president, A. E. Thornton; secretary and treasurer, G. H. Smith. Directors: A. E. Thornton, Atlanta, Ga.; M. Frank, Columbus, Miss.; Wm. Latimer, Wm. Gilchrist, G. H. Smith, Wilmington. The company has purchased all the patent rights and the plant for making fiber, etc., owned by the Acme Manufacturing Company, and in operation at Cronly, and will extend the operation of these works. The present capacity of the mills for the manufacture of pine fiber bagging is 500,000 yards, but new machinery, that will at once be added, will more than double this capacity, and enable them to turn out annually at least 1,250,000 yards of bagging.

The Redemann-Telford Steel Company, of Louisville, Ky., are continuing to make experiments with their new process. Their recent experiments have been chiefly with laminated steel. Two or more sheets of steel treated by their process, with iron sheets sandwiched in between the steels, have been welded together in one heat. After being taken from the fire, it requires a great deal of force to separate the layers, and after they have been rolled once, the welding is so firm, that it is quite impossible to separate them. The Hall Safe and Lock Company have experimented with the Redemann-Telford steel, and are said to pronounce it superior to their own laminated steel made at great expense. The Redemann-Telford steel after treatment is very soft, and holes are easily punched in it; but after tempering it is almost impossible to drill a hole into the sheets with the finest tools made of Mushet steel. The tempering is effected by heating the iron once, and then immersing it in cold water. Specimens of the tempered Redemann-Telford steel were submitted to the Navy Department, and naval officers say that the process seems to be a re-discovery of the lost art of making Damascus steel.—*Age of Steel.*

Wm. E. Mann, this city [Bangor, Maine,] has just secured a patent on an improvement in reciprocating gang saw mills. His object has been to provide means for adjusting the saws to saw any width of material, the same to be operated without stopping the machine, and also to provide a tension for the saws, which may be operated to slacken or tighten them to any extent. He also aims to provide a simple but effective apparatus with means for supporting the saws independently of the devices for operating them, whereby all strain is taken off of the adjusting devices. By a quick adjustment of saws, Mr. Mann is enabled to saw any width or thickness, and combined with this is an arrangement for straining and slackening the tension; this to be done without stopping the machinery. For this new invention is claimed a great saving in material, and perfect results. Mr. Mann was for years an extensive manufacturer of lumber at Canton, on the Androscoggin, and the above improvement in reciprocating gang saw mills is to fill a want which became strikingly apparent to him while he was in the lumber manufacturing business. Expert machinists and practical millmen have investigated the merits of the new invention, and warmly endorse it.—*Industrial Journal.*

Machinists' Supplies and Iron.

NEW YORK, Aug. 31, 1889.

Iron—American Pig—The demands are for small lots, and orders must be filled at once. These demands are, however, sufficient to keep the market firm, and furnacemen are hopeful of the future. We quote Standard Northern brands, No. 1 X Foundry, $17 to $18; No. 2, $16 to $17. Southern brands, No. 1, $16.75 to $17.25; No. 2, $16 to $16.50; Grey Forge, $15 to $15.25.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Foreman pattern maker, 10 years' experience in charge of men, is at liberty to engage. Address X. Y. Z., care of AMERICAN MACHINIST.

Wanted—Foreman for shop making iron pipe fittings, iron valves, radiators, and steam-heating specialties. "Manufacturer," AMERICAN MACHINIST.

Wanted—An educated and experienced draftsman; give references, and state salary. Address Davies & Thomas, Catasauqua, Lehigh Co., Pa.

Wanted—First-class machinists. None others need apply. Wages $2.25 per day of 10 hours, with chance for advancement if found worthy. The Pond Machine Tool Co., Plainfield, N. J.

Wanted—Draftsman on engine and pump work; state where last employed, age, experience, and salary at which you will work. Address X, care of AMERICAN MACHINIST.

Wanted—A foreman in foundry working 8 to 10 men; must be good workman for machine and house casting; steady work; married man preferred. Address BOX 18, AMERICAN MACHINIST.

Designer open to engagement in responsible position; special success in fine automatic machinery; experienced and practical in modern machine practice, and as supt. S., care AMERICAN MACHINIST.

Wanted—A mechanical engineer and draftsman, capable of making estimates for general machine shop work, and familiar with shop practice. Address P. O. Box 93, Albany, N. Y.

Wanted—A wrought-iron worker; a man who thoroughly understands wrought-iron, making grilles, stoop railings, etc. Address, stating previous experience, M. Mahony, Troy, N. Y.

Wanted—Immediately, two good draftsmen, one on machine work, one on special construction; prefer those having had some experience, and capable of designing. Trenton Iron Co., Trenton, N. J.

Wanted—Position in charge of manufacture or of design of steam machinery, by a mechanic of wide experience; now in charge of construction for a leading firm of engine builders, but desiring change. Address BOX 19, AMERICAN MACHINIST.

Wanted—Boiler maker; a live man as assistant foreman, to take charge of erecting and riveting work in a large shop. This is a good opening for a young man who is ambitious to make a reputation. Address, stating age, previous experience, and references, M., care AMERICAN MACHINIST.

Wanted—An experienced business man and thorough accountant; one familiar with the hardware and iron industries preferred. To one having the highest credentials and able to take $10,000 of stock in an established manufacturing company, a responsible position will be given in vicinity of Trenton, N. J. Address "Experience," AMERICAN MACHINIST.

Wanted—A young or middle-aged man to take charge as foreman in erecting department of machine shop engaged in building stationary and automatic engines in southern Pennsylvania; pay, $18 per week, no lost time, and extra for overtime; must be familiar with valve motions, and know how to set them; would prefer one who understands the indicator; permanent employment to a competent, energetic man. Send references, and state age; one who has had experience preferred. Intemperate men need not apply. Address BOX 17, AM. MACH.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Cheap 2d hand Planers, etc. S. M. York, Clev'd., O.

Koopman's Scales for quick measurements.

Just out; aluminum-steel hack-saws, hard but not brittle. Crescent Mfg. Co., Cleveland, O.

New catalogue of engineers' specialties free. Crescent Mfg. Co., Cleveland, O.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

August C. Christensen, 24 State st., N. Y., Consulting Engineer. Designs of all kinds of Machinery.

Turned and Highly Polished Iron and Steel Shafting a specialty. Merwin McKaig, Cumberland, Md.

Complete list of our Scales and other new tools for 2c. stamp. A. T. Koopman, Chicago.

For Sale—A small machine shop; excellent opening. Asbury, Grieder & Co., Roanoke, Va.

D. J. Kelsey, M. E., Designer of Automatic Machinery, 31 Insurance Building, New Haven, Conn.

Designs and working drawings for special machinery, tools, etc. attended to by experienced draftsman. "Draftsman," Box 107, AM. MACHINIST.

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Lord & Co., P. O. Box 1262, Phila., Pa.

Latest and best Planer and Drill Press Chucks. Expanding Mandrels. The Brightman Machine Company, Cleveland, Ohio.

For Sale—The chemical process of tinning called whitening, as applied to small articles of iron or steel. J. L. Lucas, Lynn, Mass.

Wanted—To buy second-hand lathes, planers and shapers of all sizes; must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

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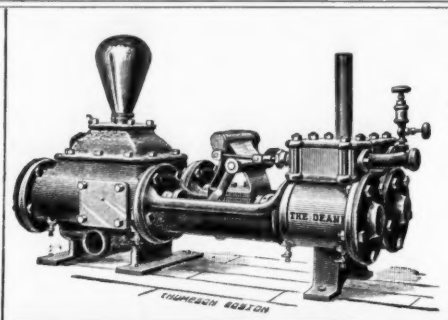
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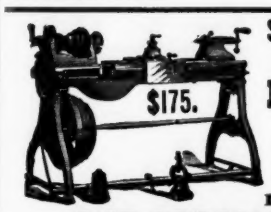
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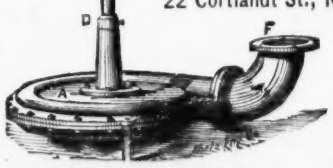
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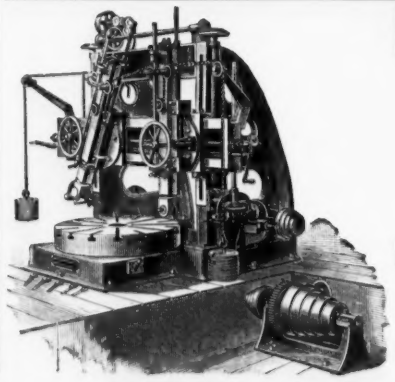
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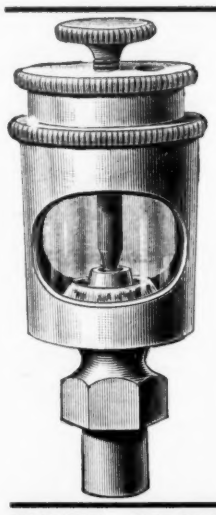

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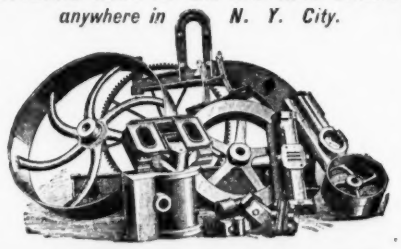

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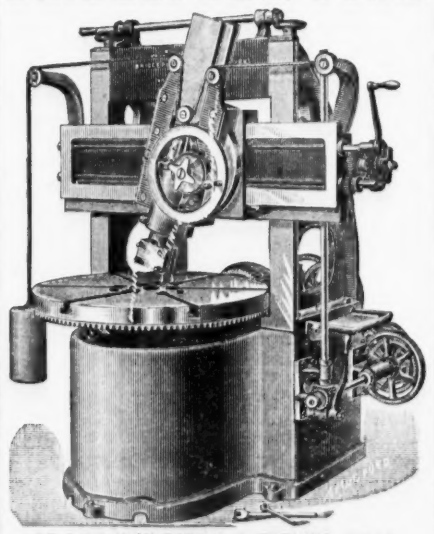

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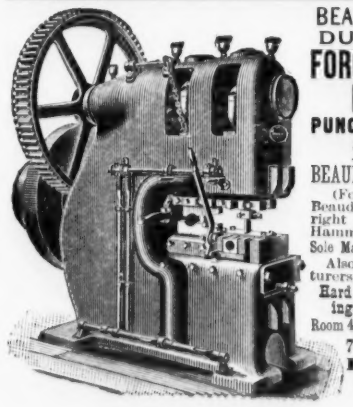

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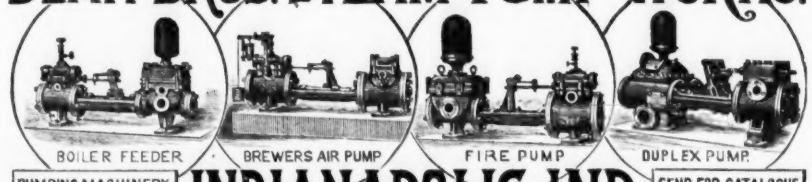

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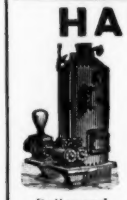

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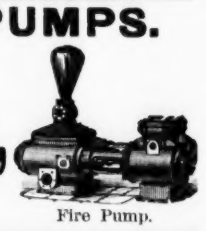

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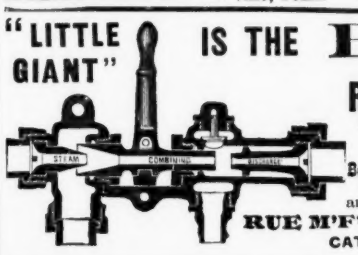

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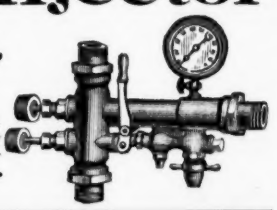

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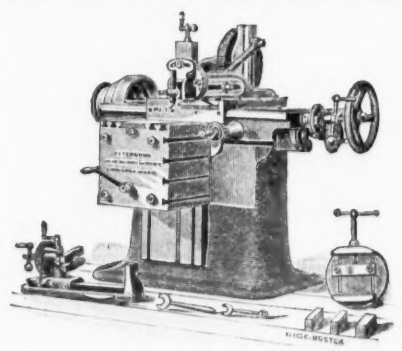

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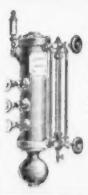

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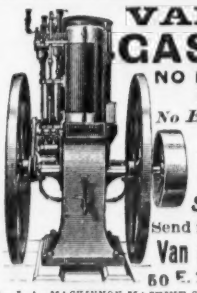

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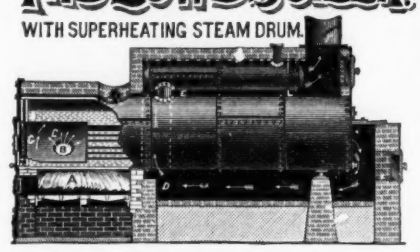

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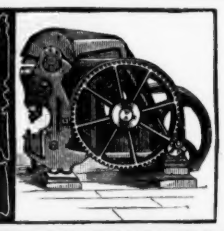

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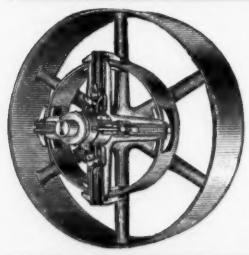

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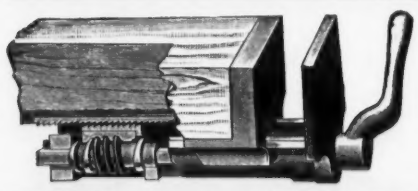

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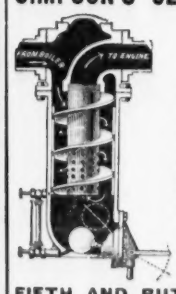

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13 "	13⅛ "
15¾ "	17 "
18 "	19¾ "
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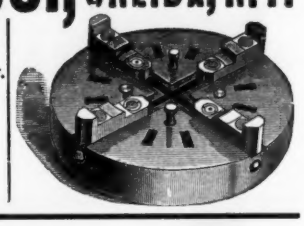

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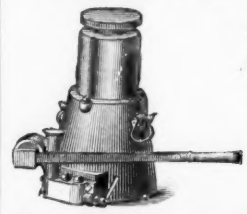

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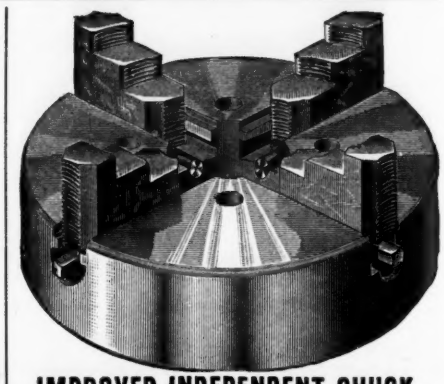

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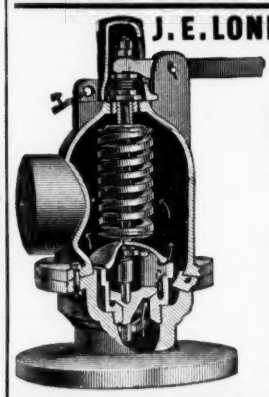

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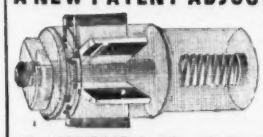

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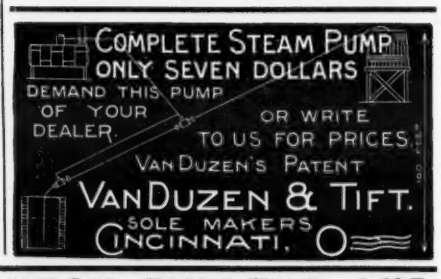

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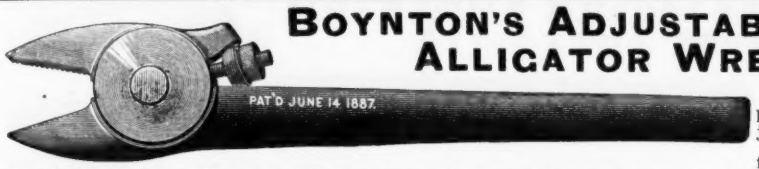

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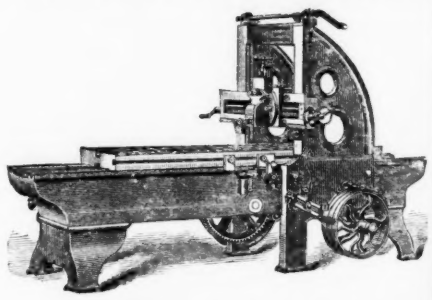

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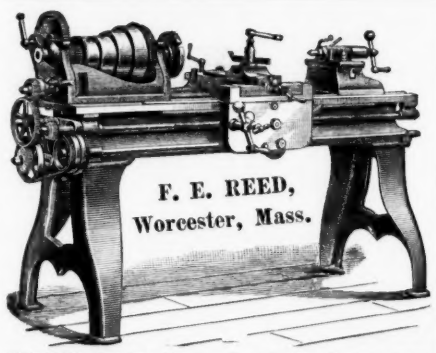

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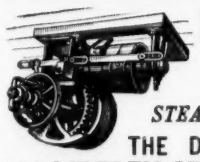

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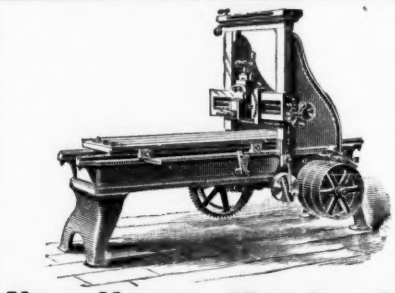

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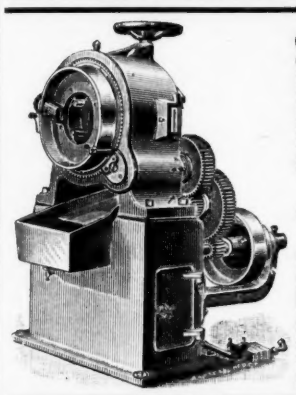

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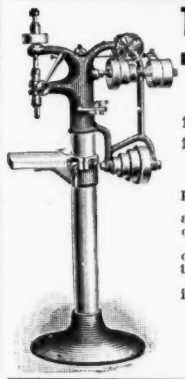

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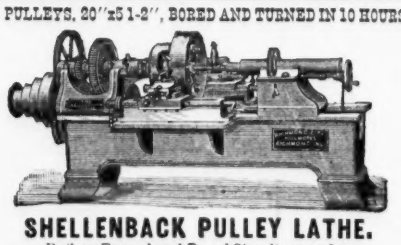

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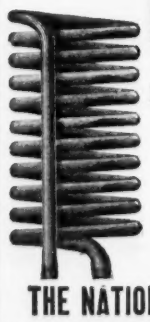

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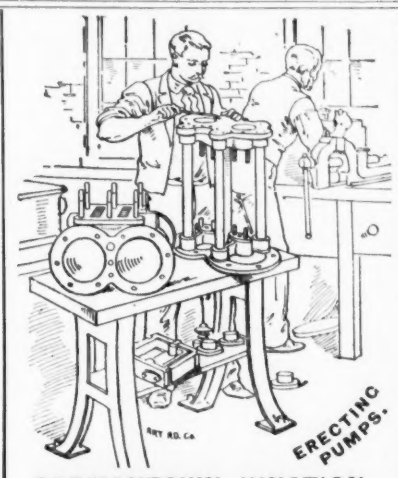

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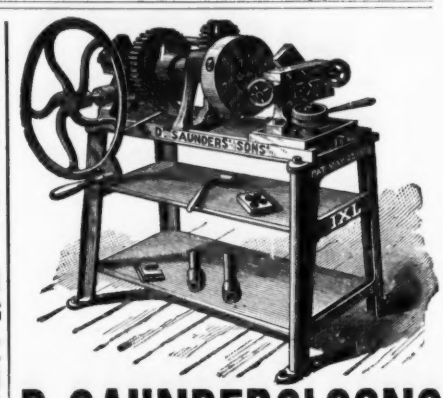

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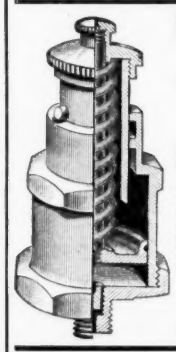

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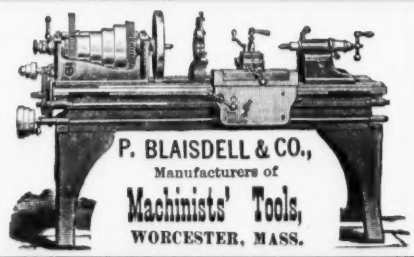

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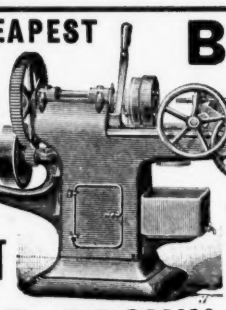

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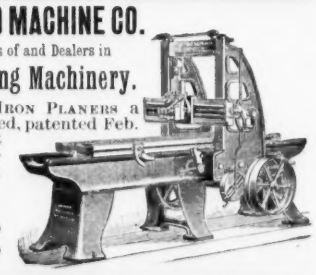

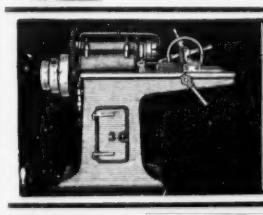

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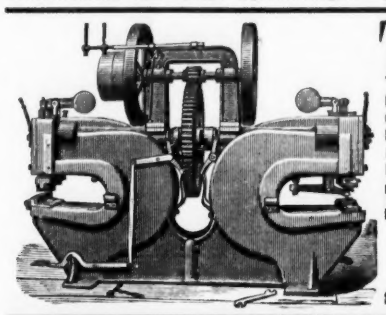

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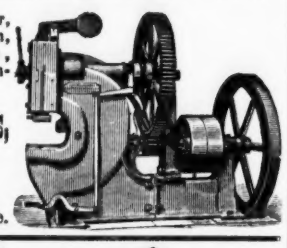

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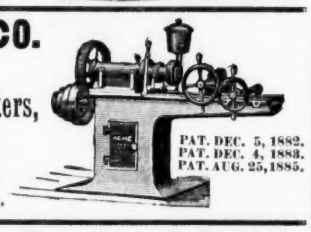
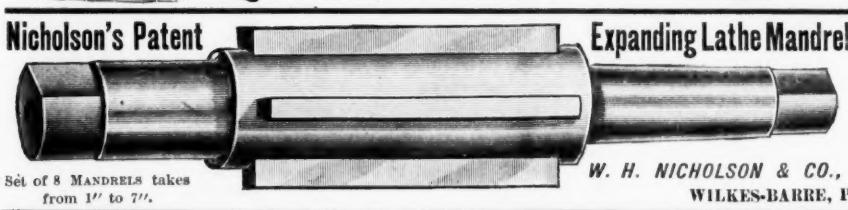

PAT. DEC. 5, 1882.
PAT. DEC. 4, 1883.
PAT. AUG. 25, 1885.

Nicholson's Patent Expanding Lathe Mandrels.



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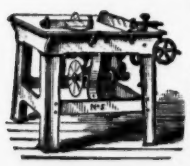

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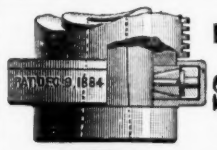

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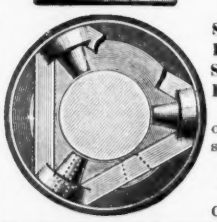

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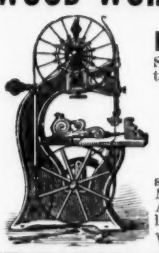

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1	24 in. x 10 ft. " "	Fitchburg,	A 1.
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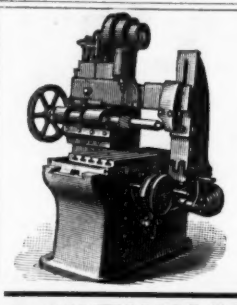

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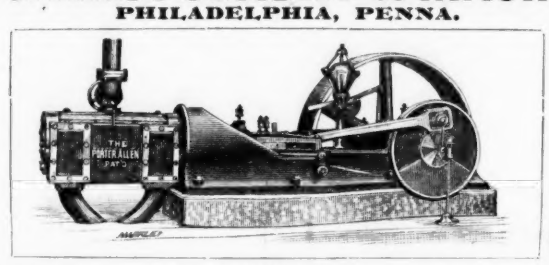

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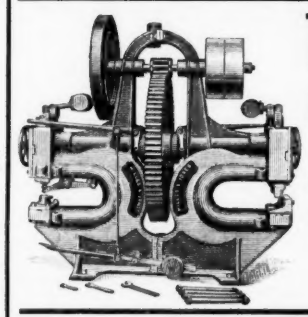

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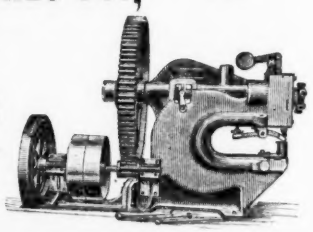

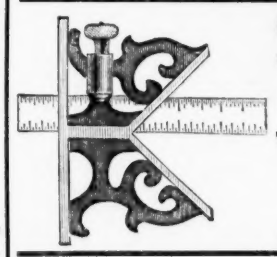

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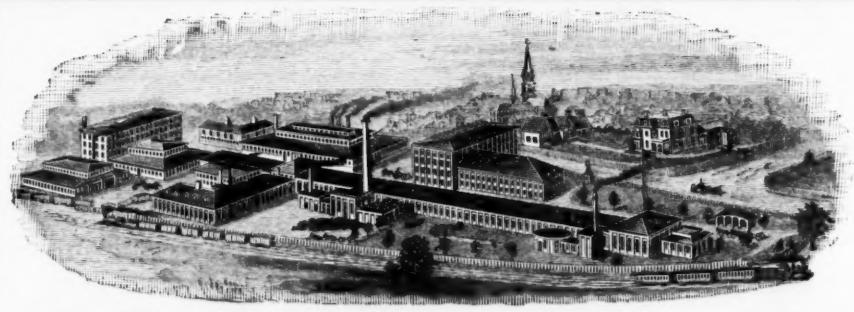

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PROVIDENCE, R.I.
Incorporated June, 1856; Established by
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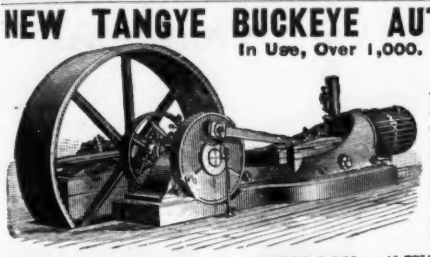

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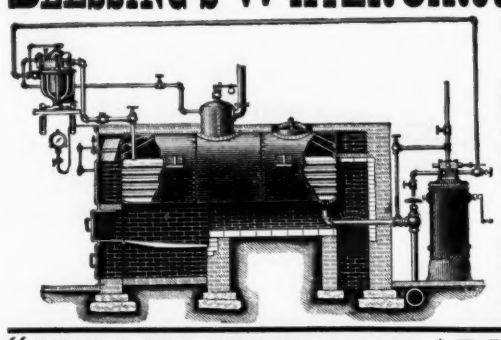

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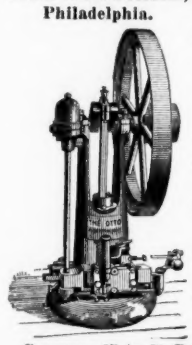

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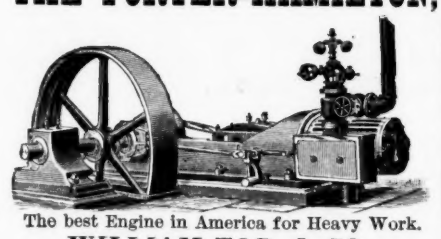

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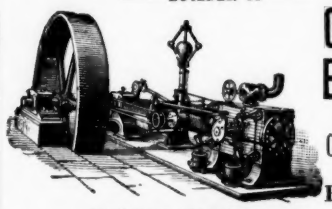

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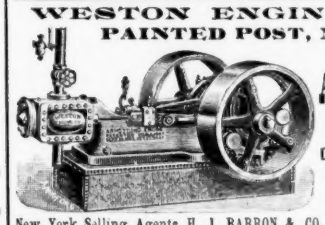

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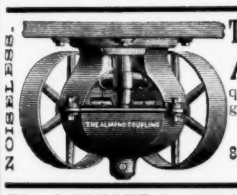

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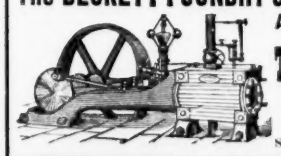

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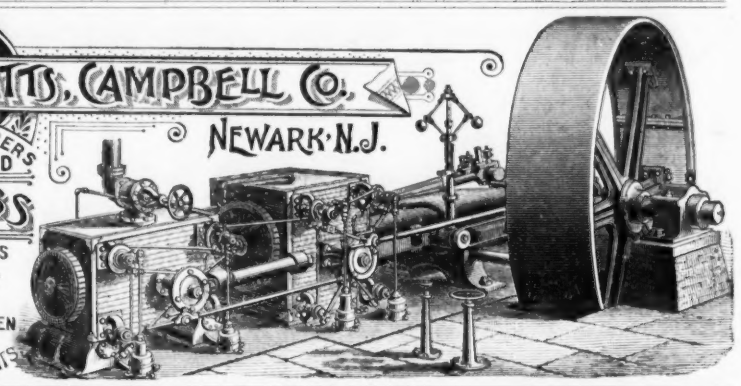

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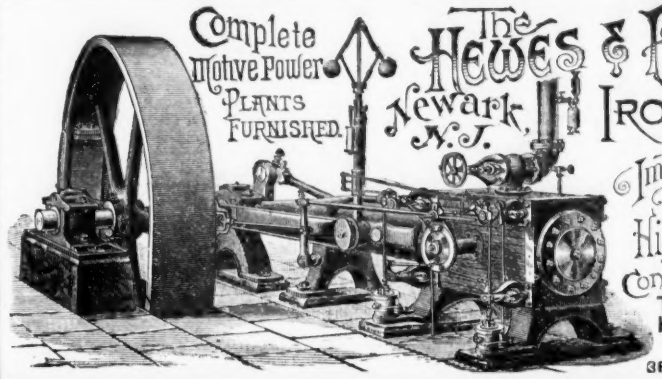

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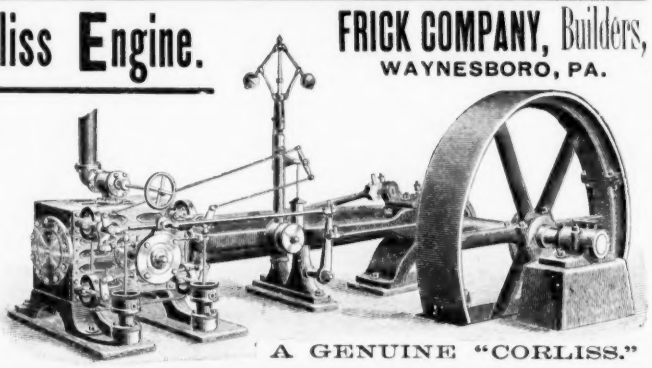

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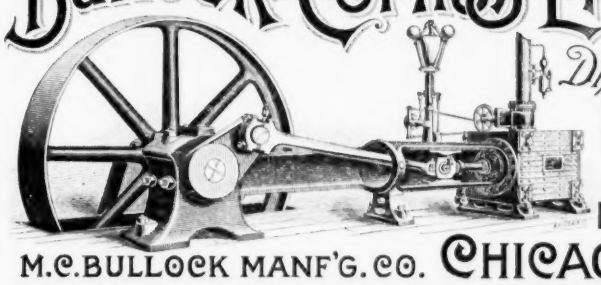

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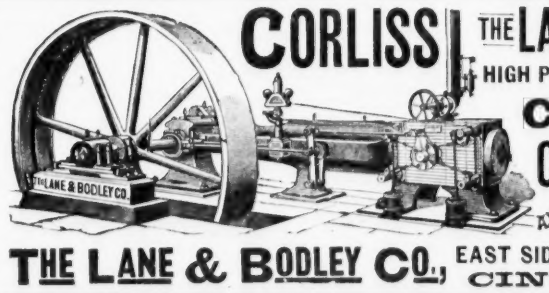

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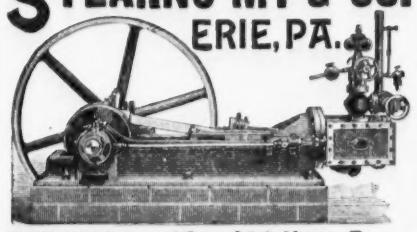

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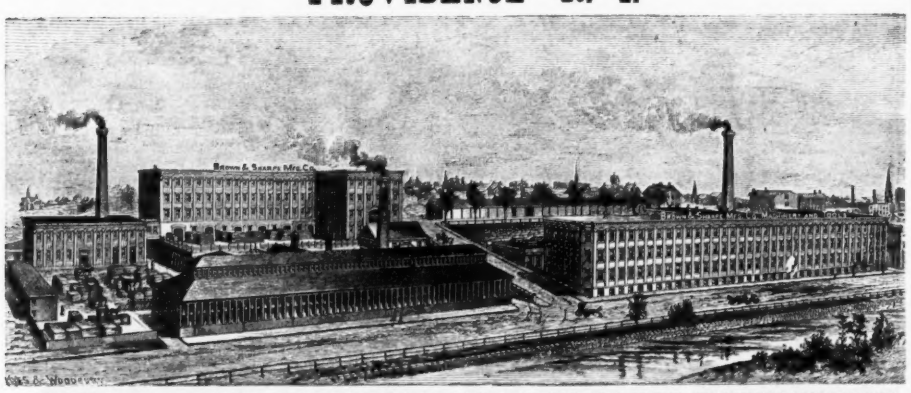

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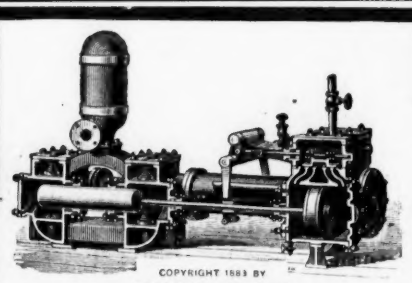

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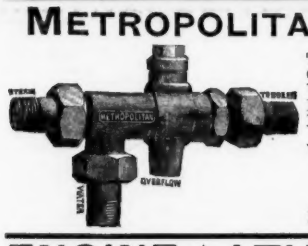

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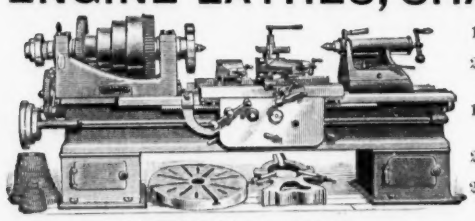

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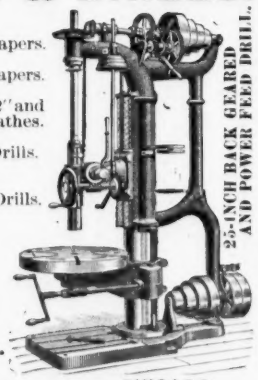

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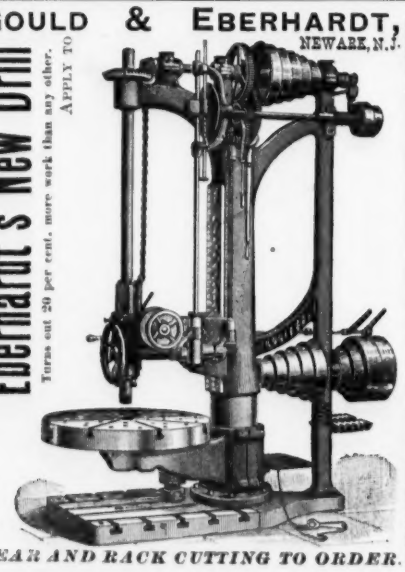

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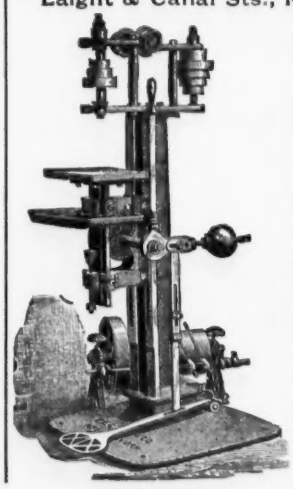

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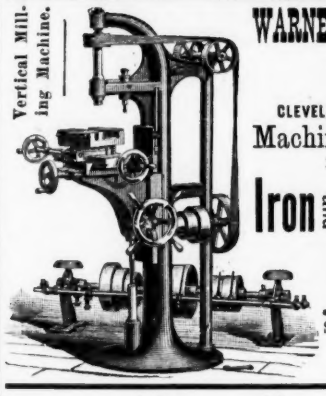

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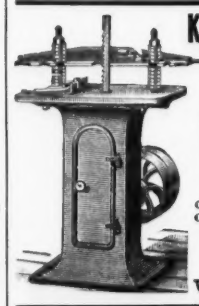

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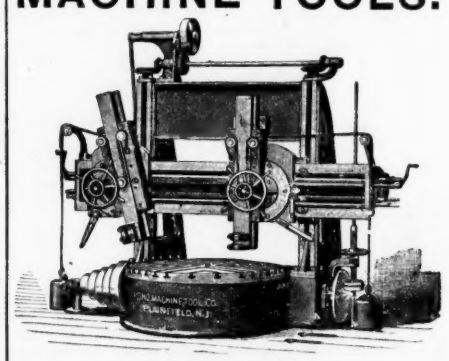

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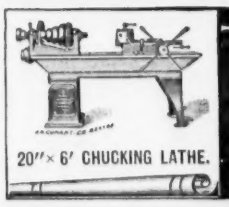

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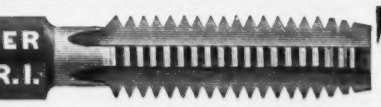

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